NAVSHIPS 92250

INSTRUCTION BOOK
for
MULTIMETER
ME-25B/U

Manufactured by
THE SIMPSON ELECTRIC COMPANY,
DIVISION OF AMERICAN GAGE AND MACHINE COMPANY
Chicago 44, Illinois

DEPARTMENT OF THE NAVY

BUREAU OF SHIPS

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DEPARTMENT OF THE NAVY
BUREAU OF SHIPS
WASHINGTON 25, D. C.

IN REPLY REFER TO
Code 993-100
18 June 1954

From: Chief, Bureau of Ships
To: All Activities Concerned with the Installation, Operation and Maintenance of the Subject Equipment

Subj: Instruction Book for Multimeter ME-25B/U, NAVSHIPS 92250

1. This is the instruction book for the subject equipment and is in effect upon receipt.

2. When superseded by a later edition, this publication shall be destroyed.

3. Extracts from this publication may be made to facilitate the preparation of other Department of Defense Publications.

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W. D. LEGGETT, JR.
Chief of Bureau

RECORD OF CORRECTIONS MADE

CHANGE NO.	DATE	SIGNATURE OF OFFICER MAKING CORRECTION

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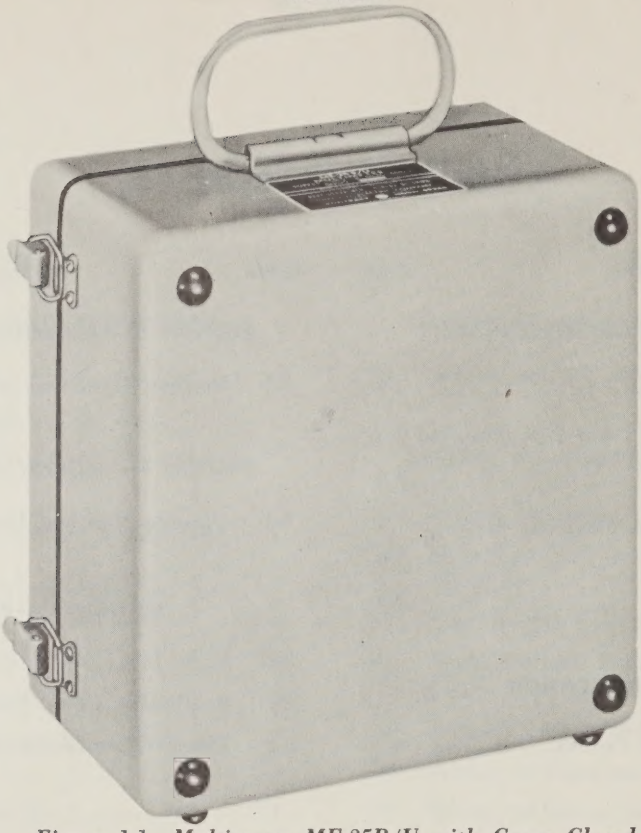


Figure 1-1. Multimeter ME-25B/U with Cover Closed.

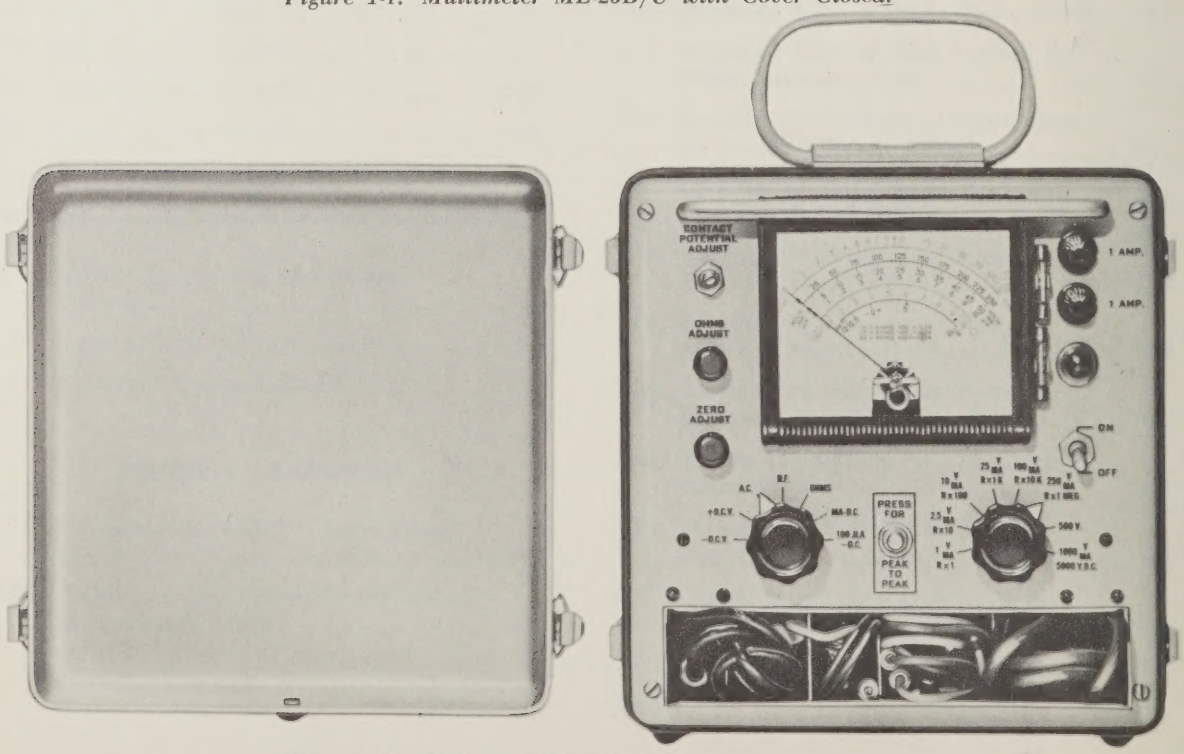


Figure 1-2. Multimeter ME-25B/U with Cover Removed.

SECTION 1
GENERAL DESCRIPTION

1. PURPOSE.

Multimeter ME-25B/U is a portable electronic combination DC voltmeter and milliammeter, AC and RF voltmeter, and ohmmeter which can be used to make a large variety of electrical measurements over a wide range of values. For measurements of voltage and resistance, it is necessary to have a source of AC power, 105 to 125 volts, single phase, 50 to 1000 cycles. This power is necessary for operation of the meter's bridge circuit. For DC current measurements, the meter does not require any outside source of power, but it is not necessary to disconnect the outside power source while making DC current measurements. Circuit design makes it possible to measure RF voltages up to 100 volts with frequencies up through 100 megacycles.

2. BRIEF DESCRIPTION.

a. PHYSICAL.

(1) GENERAL.—Multimeter ME-25B/U, illustrated in figures 1-1 and 1-2, has a smooth grey finished aluminum case and panel with black markings. The meter dial has green markings for ohms, purple-blue for 1 V.A.C., and black markings for all its other scales. The case is fitted with a steel bail-type handle on the top and rubber feet on the bottom and back. It may be used or stored in either an upright or in a horizontal position.

(2) TEST LEADS.—There are four probes with leads which are permanently attached. They are designated W-101, W-102, W-103, and W-104. Probe W-101 (black) is used to contact DC voltage and has a 5 megohm resistor, R-102, inside its probe handle. This resistor provides isolation between the instrument and the voltage source, and is part of the voltage divider network for all DC voltage inputs. The lead is shielded to prevent any interference from stray fields. The shield is grounded inside the case of the meter. Probe W-102 (red) is a general purpose probe, and is used to contact the source of DC current, resistance, and AC voltage. Probe W-103 (black) is the ground or negative return lead used with either W-101 or W-102 for all their measurements. Probe W-104 (heavy black lead) is used to contact the sources of RF voltages, and it may be used in place of W-102 to contact AC voltages if they do not exceed 100 volts. When it is not in use as a probe, W-104 must be returned to its place in the lead compartment so that its diode, V-101, can be used to rectify any AC voltage which will be contacted by W-102. The large probe head contains rectifying tube V-101, together with two capacitors, C-103 and C-104. These four probes and leads, together with AC power lead W-105, high voltage probe extension E-109, diode probe ground lead W-106, and three alligator clips, E-106, E-107, and E-108, are all stored in the special lead compartments at the bottom of the front panel when they are not in use.

(3) HIGH VOLTAGE PROBE EXTENSION.—The high voltage DC probe extension, E-109, screws on over the end of test lead W-101 to increase the range of the instrument for DC voltage measurements. There is a resistor, R-101, inside the red probe handle. A crocodile clip protected by a red insulating cover is at the other end of the lead wire.

(4) DIODE PROBE GROUND LEAD.—The diode probe ground lead, W-106, is the short black ground return lead for RF voltage measurements. It can be screwed into the side of probe W-104 when it is needed, but must be removed from the probe when W-104 is stored in the lead compartment again. This lead *must* be used for measuring RF—no option. It *can* be used in place of W-103 for AC voltage measurements when probe W-104 is used to contact the source of voltage; this is optional for the operator.

(5) ALLIGATOR CLIPS.—The three alligator clips are fitted with tapped bushings which fit on over the shoulders of probes W-101, W-102, and W-103. The alligator clips are called E-106, E-107, and E-108. They can be used as optional test lead terminations when the operator wishes to make clip connections into the circuit which he is measuring, rather than to contact the circuit points with probe tips.

(6) FRONT PANEL CONTROLS.—The front panel controls consist of a 7-position function switch, S-101; an 8-position range switch, S-102; a push switch, S-103, which is used to change the reading of AC and RF voltages from RMS to peak-to-peak; a power switch, S-104, labelled "ON" and "OFF"; pilot lamp I-101 which lights when power is on; an electrical zero adjuster for the bridge circuit, called "ZERO ADJUST"; an "OHMS ADJUST" control for full scale deflection with infinite resistance for ohms measurements; and a screwdriver controlled adjustment which compensates for contact potential for AC and RF voltage circuits. Function switch S-101 has six positions which designate the type of measurement which can be made.

b. FUNCTIONAL.—Multimeter ME-25B/U is designed to make the following electrical measurements:

(1) DC voltages up to 5000 volts, with polarity reversal.

(2) AC voltages up to 1000 volts, both RMS and Peak-To-Peak.

(3) RF voltages up to 100 volts and 100 megacycles, both RMS and Peak-To-Peak.

(4) Direct current up to 1000 milliamperes.

(5) Resistance up to 1000 megohms.

(6) Decibels from —12 to +42 DB, where zero DB is .001 watt in 600 ohms.

c. ELECTRICAL.

(1) BRIDGE CIRCUIT FOR VOLTAGE AND RESISTANCE MEASUREMENTS.—The basic meter circuit for voltage and resistance measurements is a Wheatstone Bridge. The degree of unbalance in the bridge determines the amount of meter deflection. The two sections of a dual triode tube and its two cathode resistors are the four bridge arms. The meter is connected between the two cathodes. When there is no signal applied to the bridge, it is balanced with the front panel controls so the meter reads zero. The signal which is applied to unbalance the bridge and obtain a reading is always DC voltage, whether the reading indicates DC, AC, or RF voltage, or resistance. Other circuits in Multimeter ME-25B/U are responsible for creating a DC voltage proportional to the measured signal or resistance.

(2) CIRCUIT FOR CURRENT MEASUREMENTS.—Current measuring circuits are isolated from the electronic components and power circuit. The current circuit is an ordinary DC movement with a ring shunt. There is no grounded point in the meter circuit, so it can be connected at any point in a measured circuit without regard to the DC voltage present at that point.

3. REFERENCE DATA.

a. Nomenclature: Multimeter ME-25B/U, Electronic Volt-Ohm-Milliammeter.

b. Contract Number: NObsr-49264. Date: 28 June 1950.

c. Contractor: Simpson Electric Company, Division of American Gage and Machine Company, Chicago, Ill.

d. Cognizant Naval Inspector: Inspector of Naval Material, Chicago, Ill.

e. Number of Packages Involved per Complete Shipment of Equipment, including Spare Parts: One.

f. Total Cubical Content: Crated: 1.925 cu. ft.
Uncrated: 0.335 cu. ft.

g. Total Weight: Crated: 33 lbs.
Uncrated: 12 lbs.

h. Frequency Range: 50 cycles to 100 megacycles.

i. Characteristics of Power Supply Required for Operation:

(1) Voltages: 105-125 volts, single phase, 50-1000 cycles AC.

1.5 Volts DC (one self contained dry cell, JAN type BA-30, not furnished with instrument).

(2) Maximum Battery Current Drain for Ohmmeter Circuits:

Range	Maximum Current
Rx1	150 milliamperes
Rx10	15 milliamperes
Rx100	1.5 milliamperes
Rx1K	150 microamperes
Rx10K	15 microamperes
Rx1MEG	0.15 microamperes

j. Imput Impedance:

(1) DC Volts: at least 40 megohms; with probe extension E-109, at least 200 megohms.

(2) AC Volts: approximately 10 micromicrofarads, using probe W-104, or 40 megohms partially shunted by approximately 10 micromicrofarads using probe W-102.

(3) RF Volts: approximately 10 micromicrofarads.

k. Power Consumption: 13 watts at 115 volts.

l. Overall Accuracies:

(1) DC Voltage Ranges 1, 2.5, 10, 25; 4% of full scale.

(2) DC Voltage Ranges 100, 250, 500, 1000; 5% of full scale.

(3) DC Voltage Range 5000; 6% of full scale.

(4) All AC Voltage Ranges; 5% of full scale.

(5) All RF Voltage Ranges, for frequencies through 100 megacycles; 5% of full scale.

(6) All Ohmmeter Ranges; within 3° of arc from absolute value of resistance indicated on the meter scale.

(7) All DC Current Ranges; 5% of full scale.

4. EQUIPMENT DATA.

TABLE 1-1. EQUIPMENT SUPPLIED.

QUANTITY PER EQUIPMENT	NAME OF UNIT	ARMY-NAVY TYPE DESIGNATION	OVERALL DIMENSIONS			VOLUME	WEIGHT
			HEIGHT	WIDTH	DEPTH		
1	Multimeter with Cover	ME-25B/U	9¾	9½	6¼	.335	12
1	High Voltage DC Probe Extension		11	⅝	⅝		
1	Diode Probe Ground Lead		3¾	⅜	½		
3	Alligator Clip Assembly		2 15/16	⅜	5/16		
1 set	Maintenance Spares						
2	Instruction Book	NAVSHIPS 92250	11	8½	¼	.0135	.4 approx.

Dimensions are inches, volume cubic feet, weight pounds.

TABLE 1-2. EQUIPMENT REQUIRED BUT NOT SUPPLIED.

QUANTITY PER EQUIPMENT	NAME OF UNIT	JAN DESIG-NATION	SNSN	REQUIRED USE	REQUIRED CHARACTERISTICS
1	Battery	BA-30	N17-B-7210	Ohmmeter power	1.5 volts DC

TABLE 1-3. SHIPPING DATA.

SHIPPING BOX NUMBER	NAME	DESIGNATION	DIMENSIONS			VOLUME	WEIGHT
			HEIGHT	WIDTH	DEPTH		
1	Multimeter, including maintenance spare parts	ME-25B/U	15	12	18½	1.925	33

Dimensions are inches, volume cubic feet, weight pounds.

TABLE 1-4. BASIC SIMILARITIES IN ME-25/U SERIES EQUIPMENT.

MODEL NUMBER	RANGES				MECHANICAL DESIGN
	DC VOLTAGES	AC VOLTAGES	RF VOLTAGES	CURRENT	
ME-25/U	2.5, 10, 25, 100, 250, 1000	2.5, 10, 25, 100, 250		2.5, 10, 25, 100, 250, 1000 ma	Cables stored in top of case and attached as used.
ME-25A/U	1, 2.5, 10, 25, 100, 250, 1000, 5000	1, 2.5, 10, 25, 100, 250, 1000 RMS and Peak-to-peak	1, 2.5, 10, 25, 100 RMS and Peak-to-peak	1, 2.5, 10, 25, 100, 250, 1000 ma	Cables stored in cover of case and attached as used.
ME-25B/U	1, 2.5, 10, 25, 100, 250, 500, 1000, 5000	1, 2.5, 10, 25, 100, 250, 500, 1000 RMS and Peak-to-peak	1, 2.5, 10, 25, 100 RMS and Peak-to-peak	100 ua, 1, 2.5, 10, 25, 100, 250, 500, 1000 ma.	All cables permanently connected inside case and stored in built-in compartment.

5. ELECTRON TUBE COMPLEMENT.

TABLE 1-5. TUBE COMPLEMENT.

TUBE	TYPE	STANDARD NAVY STOCK NUMBER	FUNCTION
V-101	6AL5	N16-T-56195	AC rectifier in diode probe
V-102	6X4	N16-T-56840	Power supply rectifier
V-103	6SN7GT	N16-T-56682	Bridge tube

SECTION 2
THEORY OF OPERATION

1. GENERAL.

a. METER CIRCUITS.

(1) VOLTAGE AND RESISTANCE.—The basic circuit for all voltage and resistance measurements is an electronic Wheatstone Bridge. It uses the two triode sections of bridge tube V-103 and their two cathode resistors for the four bridge arms. Indicating meter M-101 is connected between the two cathodes and will indicate zero when the two voltages are equal. It will be deflected off zero when there is a difference in the DC voltages at the two cathodes. When an external voltage is applied to the input circuits, a small DC voltage proportional to it is applied to the control grid of one half of bridge tube V-103. This changes the balance of current between the two tube halves, and creates a voltage difference between the two cathodes. The voltage difference sends a current through the meter, deflecting its pointer. Meter deflection is proportional to the DC voltage applied to the tube grid, and this is in turn proportional to the measured voltage. If Multimeter ME-25B/U is set to read resistance, DC voltage is supplied from battery BT-101.

(2) CURRENT.—Meter M-101 is connected in an ordinary milliammeter circuit for DC current measurements. It has a ring shunt for ranges from 1 to 1000 milliamperes, and has a separate shunt for its 100 microampere range. The current circuits are isolated from ground in the instrument, and also from its electronic components and power circuits.

b. DC VOLTMETER CIRCUITS.—All DC voltages to be measured are connected across a tapped bleeder network. A proportional part of the applied voltage is then connected to the signal grid of the bridge tube to cause unbalance for meter deflection. The maximum voltage applied to the tube grid is ½ volt, and this will cause full scale deflection.

c. AC VOLTMETER CIRCUITS.—Each AC voltage is rectified to produce a DC voltage equal to its peak-to-peak voltage. The DC voltage is then applied to the tapped bleeder network, and a proportional part of it to the tube grid to cause meter deflection. There are two meter circuit sensitivities available for each AC voltage range; one provides meter deflection which indicates an R. M. S. value (assuming that the input is a sine wave), and the other provides meter deflection which indicates the peak-to-peak value directly. Rectification of AC voltages takes place in the diode probe, W-104. This probe may be used to contact voltages up to 100 volts, R. M. S., but when it is not in use as a probe it is necessary for it to be in place in the lead compartment so that it will still rectify any AC voltage which is being measured.

d. RF VOLTAGE CIRCUITS.—The diode probe mentioned in paragraph *c* above also rectifies RF voltages to get a DC equivalent of the peak-to-peak voltage. This provides two meter circuit sensitivities for each range. The indications will be relatively accurate for peak-to-peak measurements of wave forms that have at least a 4×10^{-6} duty cycle, and will indicate correct R. M. S. values of sine wave inputs. The frequency range is up to 100 megacycles and the voltage range, either R. M. S. or peak-to-peak, is 100 volts.

e. OHMMETER CIRCUITS.—A self contained dry cell battery furnishes 1.5 volts to a circuit consisting of a fixed internal resistance and the measured external resistance. The ratio of external resistance to fixed internal resistance is the same as the ratio of the voltage drops across these two resistances. The voltage drop across the external resistance is applied to the grid of the bridge tube, and the meter is deflected to indicate the amount of resistance in the external circuit.

f. MILLIAMMETER CIRCUITS. — Milliampere measurements are made by a conventional circuit which measures the millivolts of drop across calibrated shunts. The meter indicates in terms of milliamperes for the various ranges.

g. MICROAMPERE CIRCUIT.—The only microampere range is 100 uA-DC. The meter movement itself has a sensitivity of 50 microamperes. With a shunt connected which has an equal resistance, the meter circuit sensitivity is set at 100 microamperes.

h. POWER SUPPLY CIRCUIT.—The power supply furnishes voltages for operating the bridge circuit for voltage and resistance measurements, for the filaments of all three tubes, and for the pilot lamp. Both sides of the input AC line are fused and have a filter capacitor. The power supply is designed for use with a 105 to 125 volt, single phase, 50 to 1000 cycle AC power source.

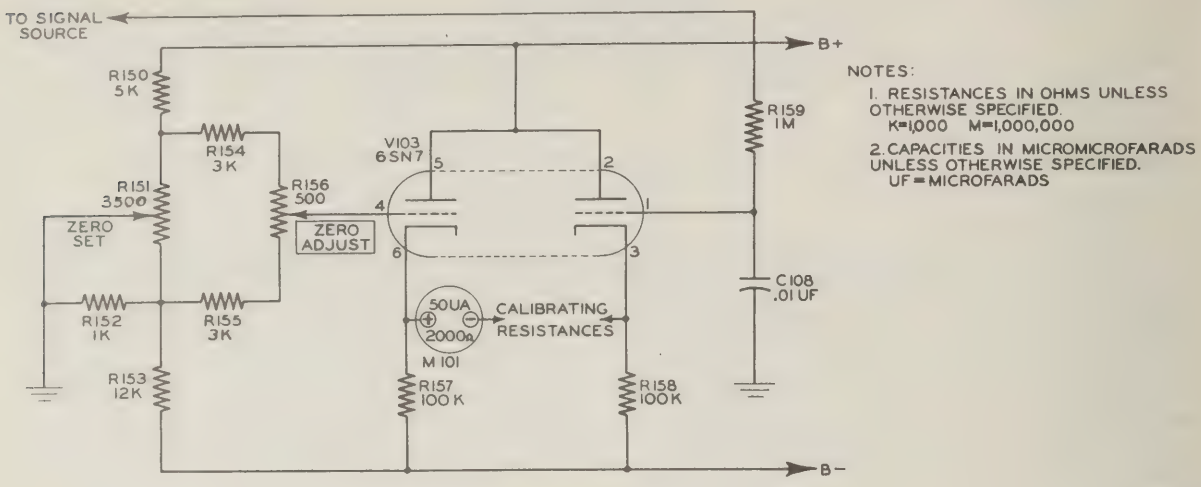


Figure 2-1. Basic Bridge and Meter Circuit For Voltage and Resistance Measurements.

2. CIRCUIT ANALYSIS.

a. BASIC METER CIRCUIT.—Figure 2-1 illustrates the bridge and meter circuit which is used for all voltage and resistance measurements. The type 6SN7GT tube, V-103, is a dual triode. The cathodes are each connected to B— of the power supply through 100K resistors, R-157 and R-158. Both plates of the tube are connected directly to B+ of the power supply. When the grid voltages, which are applied from each of two separate sources, are such that the current through the two tube halves are the same, the voltages at the cathodes are equal; and the meter, M-101, connected between these cathodes, will not be deflected because there is no voltage difference applied across it. However, if the currents are not equal, there will be a voltage difference between the two cathodes. This voltage difference is applied across meter M-101 and causes a current to flow through it and deflect its pointer. With no voltage applied through any probe, the grid of the signal section, pin 1 of tube V-103, is held at ground potential. The adjustment of the zero set screwdriver control, R-151, establishes where ground potential will be with respect to the power supply positive and negative extremes. The ZERO ADJUST control, R-156, then applies a voltage to the grid of the control section of tube V-103, pin 4, and this can be varied to regulate the current through the second tube section. When the meter reads zero, the currents are equal. When a negative voltage is applied to grid 1 through the input circuit, less current flows through the signal section of the tube than through the control section, and the voltage at the cathode end of resistor R-158 changes in a negative direction. The voltage at the top of resistor R-157 has remained at its former value, and the voltage difference between these two points is applied across meter M-101 and its calibrating resistances. The meter will then indicate an amount proportional to the amount of negative voltage applied at the grid, pin 1. When a positive voltage is applied to grid 1, the current through the signal section of the tube will be correspondingly increased, and the voltage at the top of resistor R-158 will also change in a positive direction. This, again, will cause an unbalance between the two tube sections, and will send current through the meter and its calibrating resistances; this causes a deflection of the meter pointer which is proportional to the amount of applied voltage. Note that the polarity of the meter must be reversed to provide an upward deflection on the meter scale when a positive voltage is impressed at grid 1.

b. DC VOLTMETER CIRCUIT.—DC voltages up to 1000 volts are contacted with DC probe W-101 and ground return common probe W-103. The circuit is shown in figure 2-2. The total resistance in the input circuit is 50 megohms. Resistors R-102 (in the handle of probe W-101) and R-103 act as isolating resistors for the instrument to reduce the voltage applied to the tapped divider to only half the voltage contacted by the probes. Resistors R-107 through R-115 act as a voltage divider for the remaining voltage. Part of

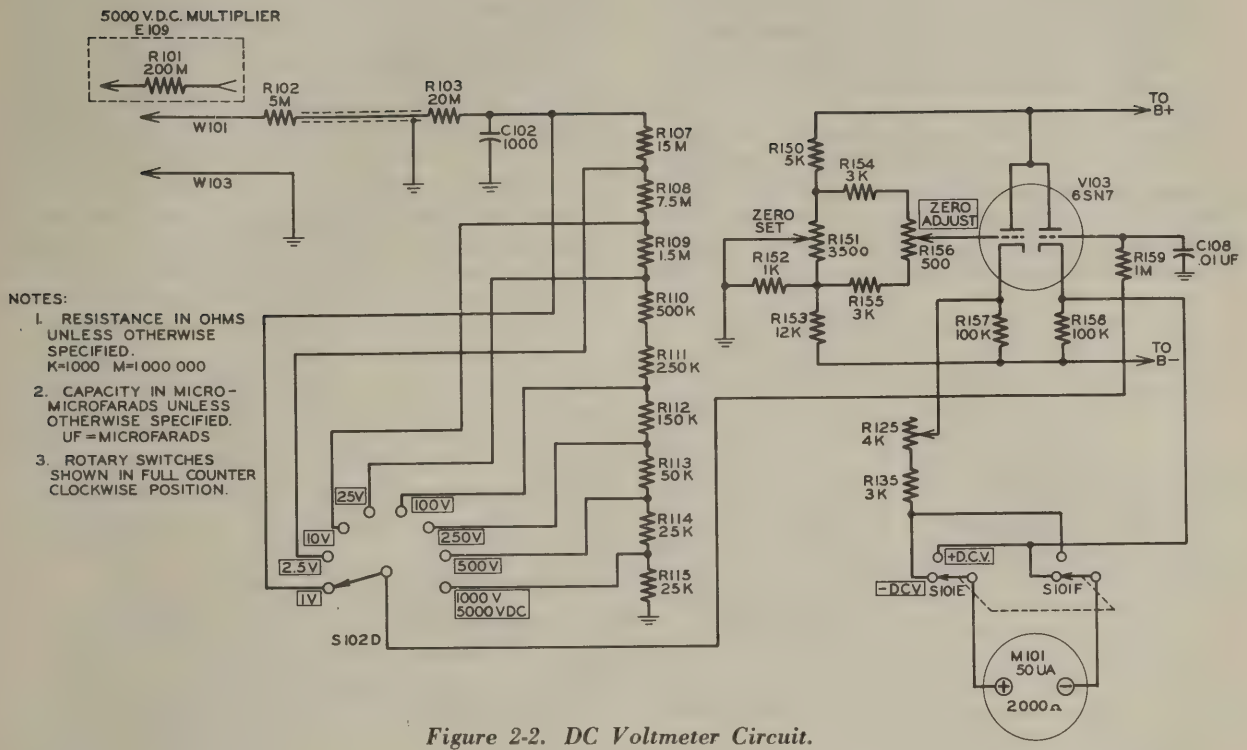


Figure 2-2. DC Voltmeter Circuit.

this is tapped by range switch S-102, and is applied to the signal grid of bridge tube V-103. If the voltage which is contacted does not exceed the range to which switch S-102 is set, the maximum voltage change applied to the grid of tube V-103 is ½ volt. This is sufficient to cause full scale deflection of meter M-101. Any smaller voltage input will cause a proportional fraction of ½ volt to be applied to the tube grid, and the meter pointer will be deflected a proportionally smaller amount. Function switch S-101 includes a provision for reversing the meter polarity. If probe W-101 contacts negative voltage, switch S-101 in its —D. C. V. position will make the meter read up-scale, or if it contacts positive polarity, the switch in its +D.C.V. position will apply the proper polarity to the meter. For measuring more than 1000 volts, but not more than 5000 volts, attach DC probe extension E-109 to the end of DC probe W-101. This increases the total input resistance to 250 megohms by connecting resistor R-101, 200 megohms, in series with the normal 50 megohm input circuit. When 5000 volts is contacted by the probe extension, E-109, ½ volt is applied to the signal grid of tube V-103 and the meter is deflected to full scale. When any fractional part of 5000 volts is contacted, a similar fractional part of ½ volt is applied to the grid, and the meter reads the same fractional part of its full scale deflection. DC probe W-101 is black and has a shield-braid which surrounds the wire throughout its length. The shield is not connected at the probe end, but is connected to ground at the termination inside the case of the instrument. This shield, together with capacitor C-102, serves to reduce any ripple or stray coupling which might be fed through the test lead into the measuring circuits of Multimeter ME-25B/U.

CAUTION

Never hold any probes while you contact and measure voltages in excess of 300 volts. Attach the probes while the equipment is turned off, and then turn the equipment on to make the reading. Turn the equipment off again before you remove the probes. These voltages are dangerous and may be fatal if contacted by operating personnel. Extreme caution should be exercised when operating under such conditions.

c. AC VOLTMETER CIRCUIT.—The portion of the circuits in Multimeter ME-25B/U used for AC voltage measurements is shown in figure 2-3. All AC voltages are rectified with tube V-101 in diode probe W-104 to produce a DC voltage equal to the peak-to-peak value of the applied AC voltage. The resulting DC voltage is applied across the divider network. Range switch S-102 selects some portion of it to connect to the signal grid of bridge tube V-103. Since this DC voltage is proportional to the AC voltage which is being measured, and the meter deflection is proportional to the DC voltage, the meter indicates AC voltage directly. The most common AC voltage measurement consists of determining the RMS value of a sine wave form of voltage; for this reason, meter M-101 is calibrated in RMS values for a sine waveform. Press switch S-103 which shorts out part of the meter calibrating resistance, providing 2.828 times as much meter deflection as is obtained with the same voltage input without pressing switch S-103. The reading thus obtained is the peak to peak value and is correct regardless of the type of waveform being measured provided the duty cycle is greater than 4×10^{-6}.

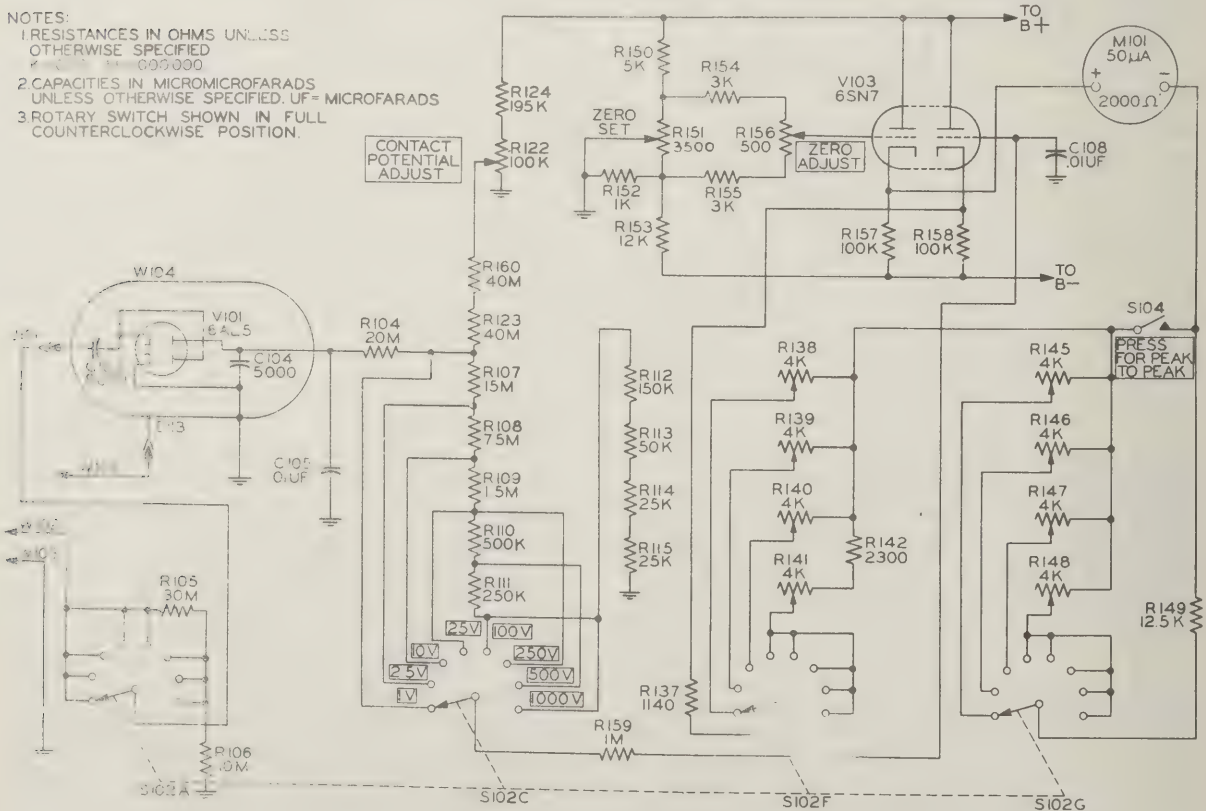


Figure 2-3. AC Voltmeter Circuit.

(1). PROBES FOR AC MEASUREMENTS.—AC voltages can be measured with any of several combinations of probes. Diode probe W-104 can be used to contact the source of AC voltage directly, providing the voltage has a value no greater than 100 volts, RMS. If the diode probe is used as the test lead, either the short diode probe ground lead W-106 may be screwed into the housing of the diode probe, A-109, and used as the ground return for the measured signal, or common test lead W-103 may be used as the ground return. (See paragraph 2*d* for RF measurements.) For voltages greater than 100 volts RMS, do not use diode probe W-104 to contact the voltage being measured, or it will be damaged.

WARNING

Do not use diode probe W-104 to contact any AC voltage greater than 100 volts RMS. The probe will be damaged.

The red test lead, W-102, can be used to contact any AC voltage up to 1000 volts RMS. Common test lead W-103 is then used as the ground return. Alligator clips E-106 and E-107 may be screwed over the ends of leads W-102 and W-103 to make connections to circuits more convenient if it is desired.

CAUTION

Never hold any probes while you contact and measure voltages in excess of 300 volts. Attach the probes while the equipment is turned off and then turn the equipment on to make the reading. Turn the equipment off again before you disconnect the probes. These voltages are dangerous and may be fatal if contacted by operating personnel. Extreme caution should be exercised when working under such conditions.

(2). THEORY OF OPERATION.—When diode probe W-104 is not being used to contact voltage, store it in the test lead compartment with its tip, E-112, firmly seated in jack J-101. This is necessary to allow tube V-101 to rectify all AC voltages which you measure with the instrument. In the lowest five ranges (1, 2.5, 10, 25, and 100 volts) the input voltage is impressed directly across rectifier tube V-101, with capacitors C-103 and C-104 in series with the tube. The resulting DC voltage, which has a value proportional to the impressed AC voltage, is applied to a bleeder network consisting of R-104 in series with two parallel paths to ground. One of the parallel paths contains isolating resistors R-123 and R-160 in series with a portion of the CONTACT POTENTIAL ADJUST resistor, R-122. The second parallel path contains the DC voltage divider network with resistors R-107 through R-115 all in series. A portion of the DC voltage is then applied to the signal grid of tube V-103, unbalancing the currents through the two halves of the tube and applying a voltage difference to meter M-101. Sections F and G of range switch S-102 select which set of calibrated resistors will be used as series multipliers for the meter circuit. In the 1 V position, resistors R-137, R-138, R-145, and R-149 are all in series with each other and with meter M-101. Resistors R-138 and R-145 are variable resistors, adjusted to values which will allow the meter to register proper values for voltages of 1 volt or less, RMS. (See CALIBRATION PROCEDURES, paragraph 7-9.) Press the PRESS FOR PEAK TO PEAK switch, S-103, to short out resistors R-145 and R-149; this provides more deflection of the meter pointer for the same applied voltage. The ratio of deflections with switch S-103 closed and opened is 2.828 to 1. If the applied voltage has a sine wave form, the ratio of its peak-to-peak value and its RMS value is the same as the ratio of these indications. Both are meaningful indications. However, if the wave form is not a true sine wave, disregard the RMS reading and use only the peak-to-peak value. In the 2.5 volt position of range switch S-102, resistor R-139 replaces R-138 and resistor R-146 replaces R-145 in the above description. For the 10 V position, resistors R-140 and R-147 replace R-138 and R-145 respectively. For the ranges from 25 volts up to 1000 volts, resistors R-141 and R-142 in series replace R-138, and resistor R-148 replaces R-145. When voltages greater than 100 volts are measured, section A of range switch S-102 sets up a divider network for the AC voltage applied to diode probe W-104 and section C of switch S-102 sets the meter circuit sensitivity for the portion of tapped AC voltage.

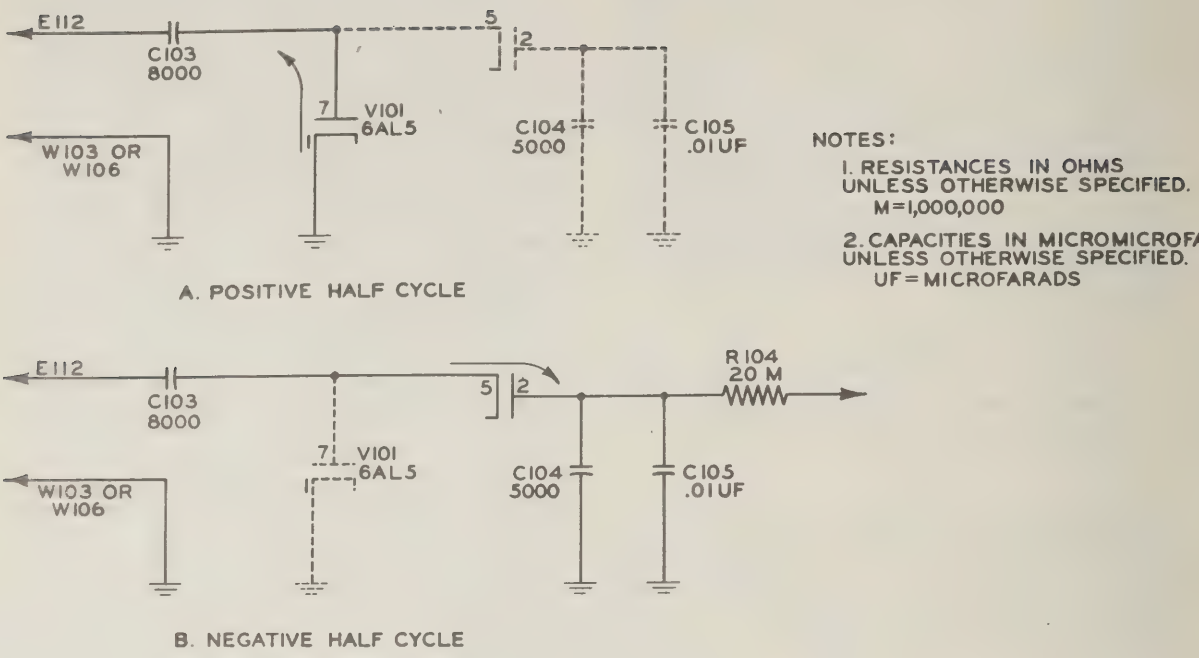


Figure 2-4. Equivalent Circuit for Diode Probe W-104.

(3) RECTIFYING ACTION OF PROBE W-104.—Figure 2-4 illustrates the equivalent electrical circuits which exist inside test probe W-104 during the alternate half cycles of the AC input. During the first half of the positive half cycle, section A of rectifier tube V-101 conducts, charging capacitor C-103 to the peak value of the applied voltage. During the next 90° of cycle time, this voltage is applied across the B section of rectifier tube V-101 and sends current through it to charge capacitors C-104 and C-105 to the peak value. Then during the first half of the negative half cycle, the B section of the tube conducts again, increasing the charge on capacitors C-104 and C-105 by an amount equal to the peak value again; the total charge on capacitors C-104 and C-105 is then equal to the peak-to-peak value of the applied AC voltage. This DC value is applied to the DC voltage divider network and any amount which is drained off the capacitor through the divider is replenished quickly by the succeeding cycle of AC voltage.

(4) CONTACT POTENTIAL.—Rectifier tube V-101 has a tendency to pass electrons from each heated cathode to its plate when there is no external applied voltage. This phenomenon is known as "Edison Effect." When the cathode is heated, it forms a space charge of emitted electrons around itself. The collective strength of this space charge provides a potential which is below the ground potential at the plate. Since there is a complete DC path through which the electrons can pass and return to the cathode, they will move through this complete circuit. Thus, even though there is no voltage which is being measured, a small current will flow through the voltage divider. It is enough to cause meter deflection. The voltage which the meter indicates is called contact potential. A power supply bleeder network consisting of resistors R-124 and R-122 in series between B+ and ground provides a source of positive voltage at the variable tapped point in resistor R-122. A positive voltage is tapped in resistor R-122 and applied through isolating resistors R-123 and R-160 to the top of the DC voltage divider network. CONTACT POTENTIAL ADJUST resistor R-122 is set so the tapped voltage from it is equal to the negative voltage furnished by the Edison Effect from the rectifier tube. This results in cancellation of the voltage across the DC divider network, and the meter will read zero. The amount of voltage to be counteracted is affected by the conditions existing within rectifier tube V-101. It will change as the tube ages and when the tube is replaced. Touch up the adjustment of the CONTACT POTENTIAL ADJUST control whenever it is necessary. The zero meter indication with function switch S-101 at A.C. or R.F. will be on the zero mark when the control is set correctly.

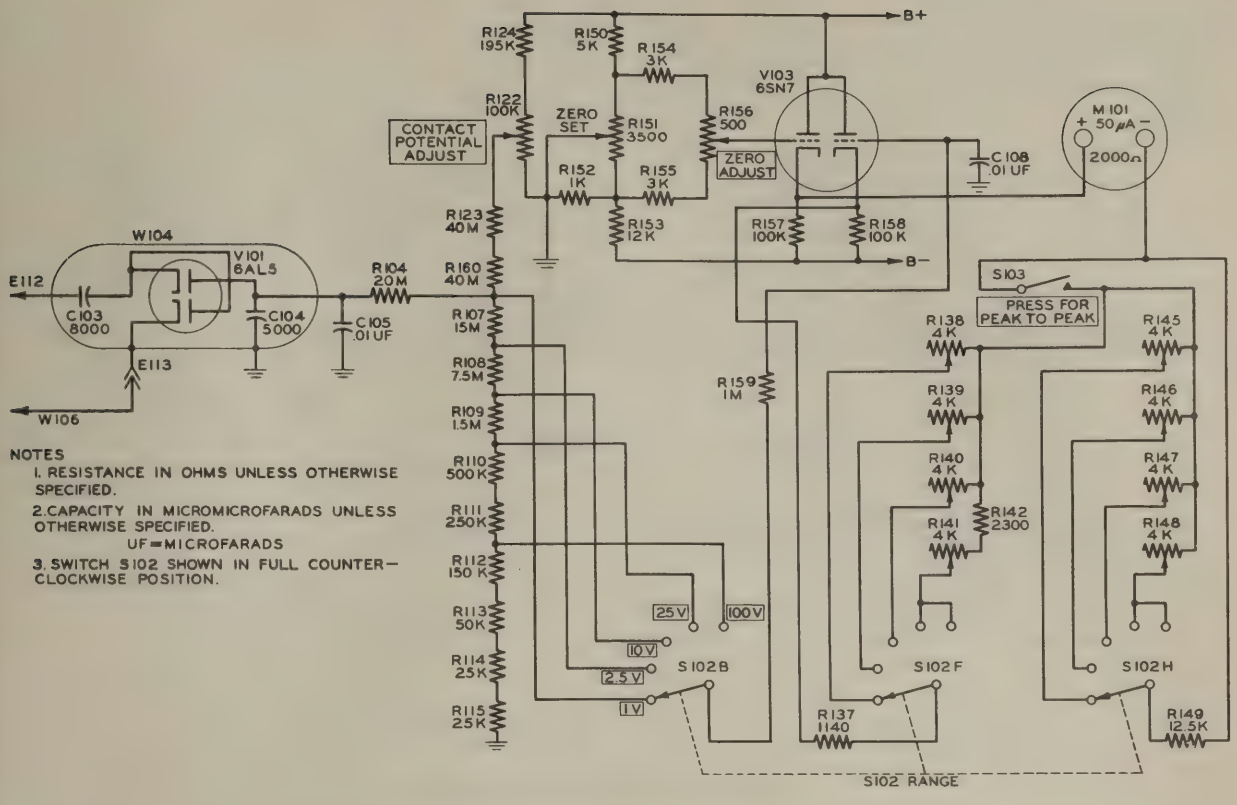


Figure 2-5. RF Voltmeter Circuit.

d. RF VOLTMETER CIRCUITS.—The portion of circuits in Multimeter ME-25B/U which is used for RF measurements is shown in figure 2-5. All RF voltages are applied directly to the diode probe, W-104, and are rectified with tube V-101 and the associated circuit inside the probe handle. Ground lead W-106, screwed in place on the side of W-104, is the ground return for RF measurements. The resulting DC voltage is applied across the divider network and a portion of it is connected to the signal grid of bridge tube V-103. Since this DC value is proportional to the peak-to-peak value of the applied voltage, and meter deflection is proportional to the DC voltage, the meter indicates RF voltage directly. If the voltage being measured has a true sine wave form, the RMS value can be read directly on meter M-101. However, if the wave form is any shape other than a sine wave, this RMS value has no meaning; press the switch marked PRESS FOR PEAK TO PEAK, S-103, to obtain a peak-to-peak reading on the meter. The peak-to-peak value which is obtained by pressing switch S-103 is correct for all wave forms, providing they have a duty cycle of at least 4×10^{-6}. The theory of operation of Multimeter ME-25B/U is the same for RF voltage measurements as was explained in paragraph *c* above for AC voltage measurements. All voltages are measured with diode probe W-104 and ground lead W-106. The frequency range of the instrument for RF voltage measurements is up to 100 megacycles, with its specified accuracy. Relative voltage values for much higher frequencies will also be indicated. The voltage ranges for RF measurements are 1, 2.5, 10, 25, and 100 volts, both RMS and peak-to-peak.

WARNING

Do not use diode probe W-104 to contact any RF voltage greater than 100 volts RMS. The probe will be damaged.

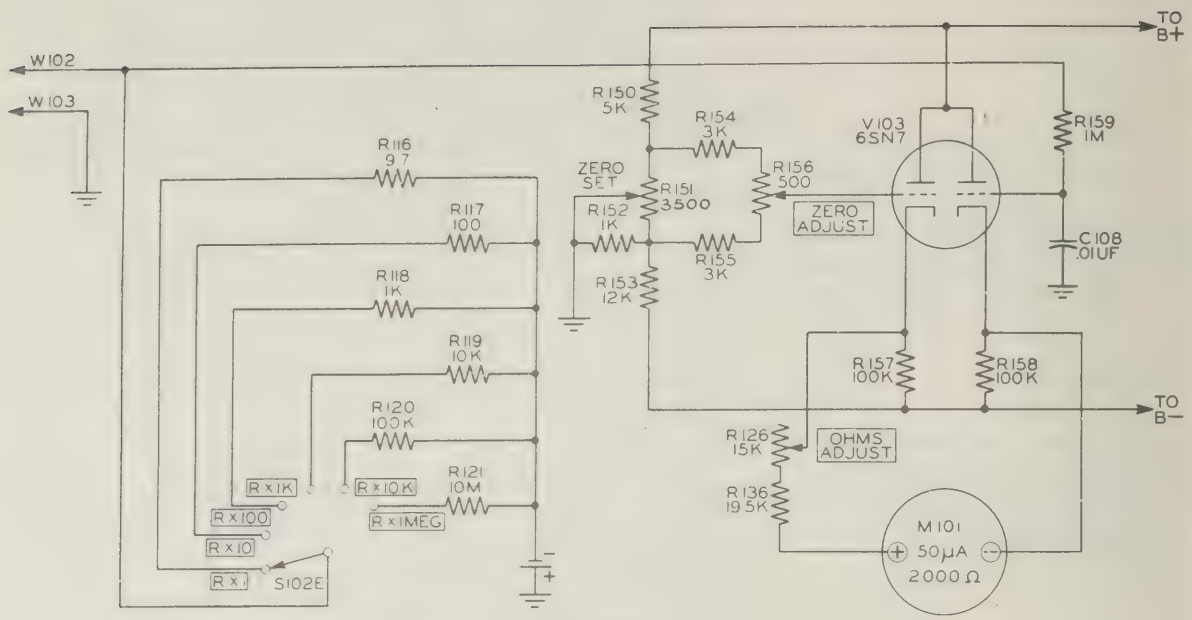


Figure 2-6. Ohmmeter Circuit.

e. OHMMETER CIRCUIT.—Resistance measurements are made with probes W-102 and W-103. When they are shorted together, the signal grid of tube V-103 is connected to ground potential, and no meter deflection occurs. When the probes are separated with infinite resistance, the voltage at the signal grid of the bridge tube is 1.5 volts negative with respect to ground, and meter M-101 will read full scale deflection. Figure 2-6 shows the portion of Multimeter ME-25B/U circuits which is used for resistance measurements. Battery BT-101 furnishes 1.5 volts. The OHMS ADJUST potentiometer, R-126, is a meter sensitivity adjustment which compensates for aging of the battery. The setting of range switch S-102 determines which of the range resistors is in the circuit; these are resistors R-116, R-117, R-118, R-119, R-120, and R-121. The range resistor and the battery are in series with the test leads. When any external resistance is contacted with the test probes, this resistance is in series with the range resistance. Part of the battery voltage is dropped across each of the resistors, and the amount of voltage across the resistance between the test probes is the amount which is connected to the signal grid of bridge tube V-103. The greater the external resistance, the more will be the applied voltage for the grid, and the less this resistance, the less the voltage will be. The green scale markings at the top of the dial of meter M-101 indicate the amount of added external resistance. Zero is at the left hand side, and infinity is at the right. The position of range switch S-102 indicates what multiplier value to apply to the reading, such as Rx1, Rx10, etc. Read the scale and then multiply the reading by the multiplier value indicated at the switch position to obtain the full value of the measured resistance. Readings are more accurate in the center portion of this type of scale than toward its ends. When you can read an indication on two or more ranges, use the one nearest the center of the scale.

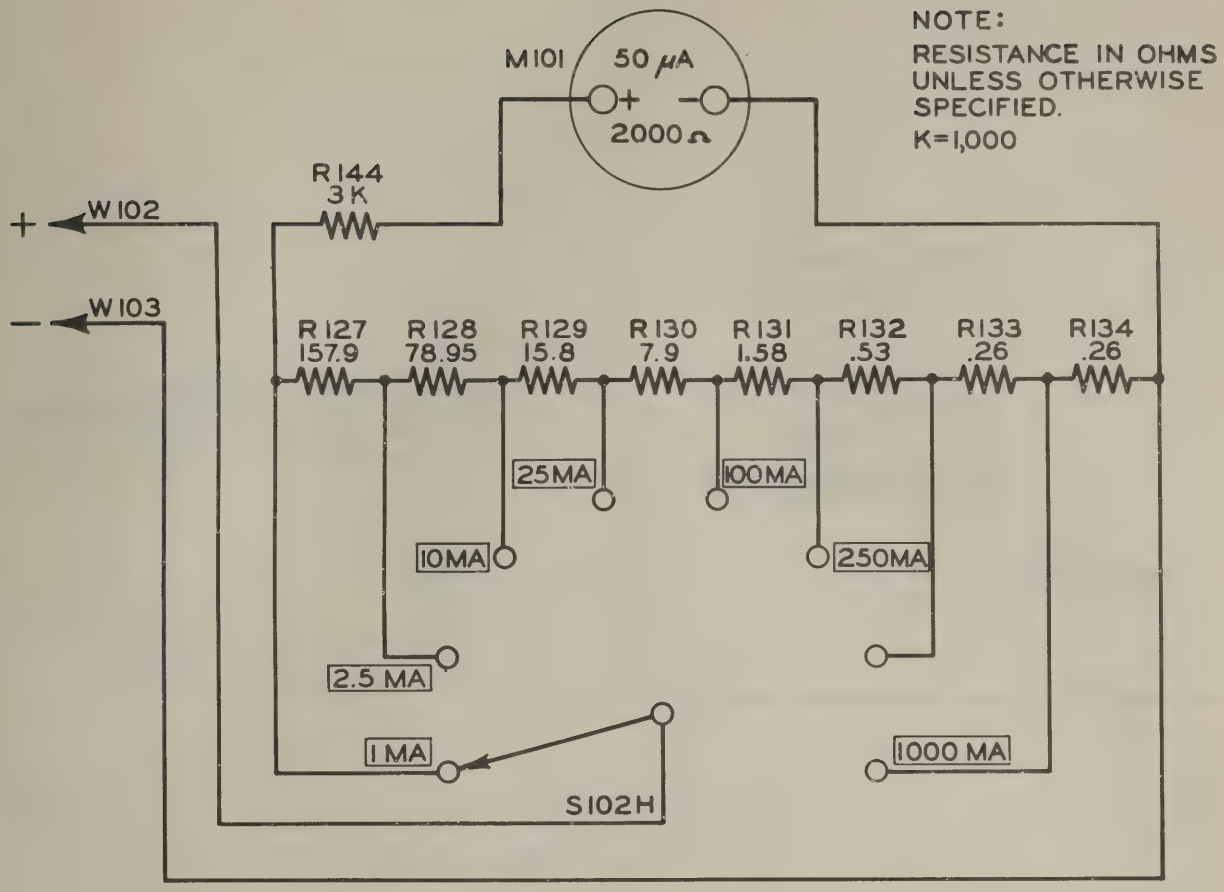


Figure 2-7. Milliammeter Circuit.

f. MILLIAMMETER CIRCUIT.—Figure 2-7 shows the milliammeter circuit for Multimeter ME-25B/U. It uses meter M-101 in series with resistor R-144, and a ring shunt in parallel with this combination. Test leads W-102 and W-103 are used for current measurements. Test lead W-102 is the positive lead, and test lead W-103 is negative. There is no grounded point in the milliammeter circuit, so the meter can be connected at any point in the measured circuit.

CAUTION

Do not connect meter leads in any circuit while voltage is present in the circuit. Turn off the power to the circuit while you connect the meter and then turn on the power while you make the measurements. Turn off the power again before you remove the leads from the circuit.

The milliammeter circuit is entirely independent of the electronic portions of Multimeter ME-25B/U circuits, and it does not matter whether power lead W-105 is connected to an AC source, or whether power switch S-104 is set at ON or at OFF. The current, passing through the circuit from probe W-102 to probe W-103, will divide through the parallel circuit in inverse proportion to the resistances of the two paths. The portion which passes through meter M-101 causes deflection proportional to the total current. The position of range switch S-102 indicates how much total current has to be flowing to make the meter read full scale deflection. The maximum voltage drop for milliammeter measurements is 250 millivolts for any range.

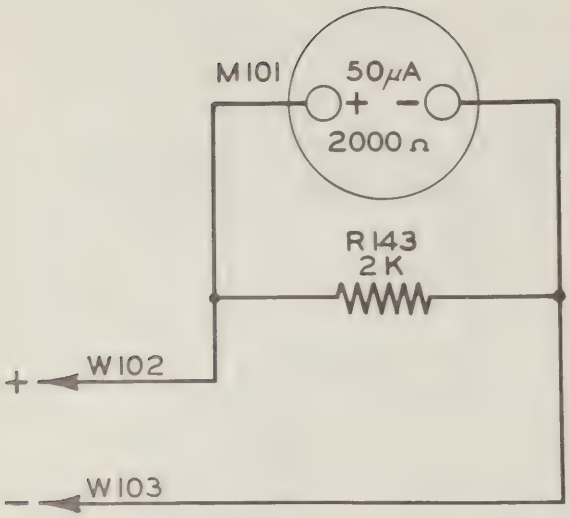


Figure 2-8. Microammeter Circuit.

g. MICROAMMETER CIRCUIT. — When switch S-101 is set at 100 uA-D.C., the circuit which is connected in Multimeter ME-25B/U is shown in figure 2-8. There is no range selection beyond the setting of function switch S-101. The meter sensitivity is 50 microamperes and has a resistance of 2000 ohms. When it is shunted with resistor R-143, which has an equal resistance, the current divides with half through the meter, M-101, and the other half through resistor R-143. When 100 microamperes flows through the circuit from test lead W-102 to test lead W-103, 50 microamperes will flow through meter M-101 to cause full scale deflection. Any part of 100 microamperes through the circuit will cause a proportionally smaller amount of current to flow through meter M-101, and a proportional deflection will result. There is no grounded point in the microammeter circuit, so the instrument can be connected safely at any point in the measured circuit. The microammeter circuit is entirely independent of the electronic portions of Multimeter ME-25B/U circuits, and it does not matter whether the power lead, W-105, is connected to an AC source, or whether power switch S-104 is set at ON or at OFF. The maximum voltage drop for microampere measurements is 100 millivolts.

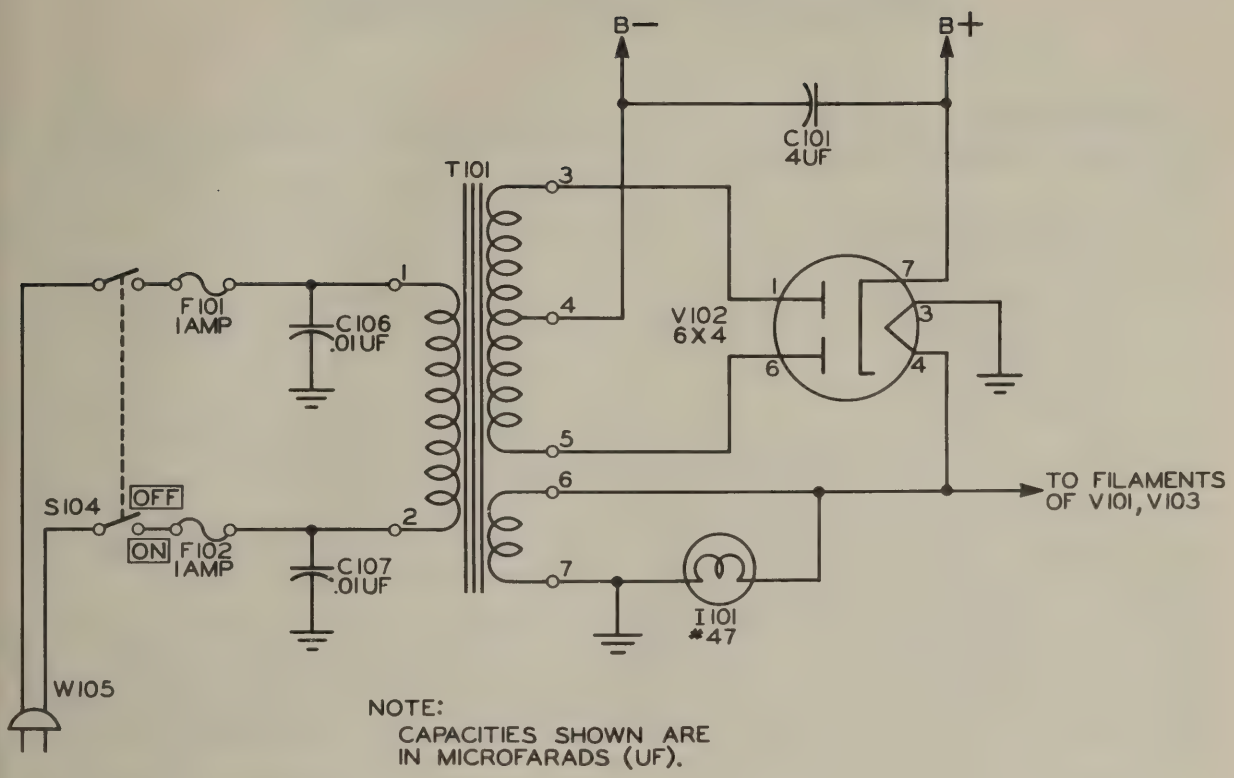


Figure 2-9. Power Supply Circuit.

h. POWER SUPPLY.—The power supply for Multimeter ME-25B/U is shown in figure 2-9. It is necessary to use it to furnish both DC and AC voltages to operate the meter circuits for all voltage and resistance measurements. It consists of line cord W-105, power switch S-104, fuses F-101 and F-102, line filter capacitors C-106 and C-107, power transformer T-101, filter capacitor C-101, and pilot lamp I-101. Terminals 6 and 7 of transformer T-101 furnish 6.3 volts AC to light lamp I-101 when the power is on, and to heat the filaments of tubes V-101, V-102, and V-103. The high voltage secondary winding is center tapped (terminal 4) for a full wave rectifier operation of tube V-102. The transformer center tap is the source of B— DC voltage, and the cathode of the 6X4 tube, V-102, is the source of B+. The total DC voltage is 175 volts from B+ to B—. The point at which the voltage is grounded to the chassis is about 50 volts below B+. This is varied with the setting of the zero set control, R-151.

SECTION 3
INSTALLATION AND ADJUSTMENT

1. COMPONENT PARTS.

Each Multimeter ME-25B/U consists of the following parts:

1 Multimeter ME-25B/U
1 Cover
1 High Voltage DC Probe Extension
3 Alligator Clips (for optional test lead termination)
1 Diode Probe Ground Lead
2 Instruction Books

All these parts, except the instructions books, are packed into the single portable case. The case and cover are made of a heavy drawn aluminum. The cover clamps over the face of the instrument when it is not in use. When the cover is clamped in position, the case is watertight. The cover has one rubber foot which should be on the bottom of the instrument when the cover is clamped in position. It helps the four rubber feet on the bottom of the instrument case support the instrument when it is stored in an upright position.

2. UNPACKING.

Each Multimeter ME-25B/U is packed in a substantial wooden case which is sufficiently sturdy and protective to the equipment to permit it to be exposed to the weather for an indefinite time. The unpacking procedure is indicated in the cutaway drawing, figure 3-2. When you unpack an instrument, be careful to prevent damage to the case of the instrument or to its movement.

3. BATTERY INSTALLATION.

Before you use Multimeter ME-25B/U for resistance measurements, install one battery, JAN type BA-30, in the instrument. Figure 3-3 shows where the battery will be installed inside the case of the instrument. Use the following procedure:

a. Remove the four large binder head screws through the corners of the front panel. Pull the front panel straight out of the case.

b. Turn the front panel around so that you view it as in figure 3-3. Locate H-101 and E-118 in the instrument. On chassis H-101, there is a trough into which the battery will fit.

c. Loosen the screw which holds contact E-118 to chassis H-101, and turn contact E-118 to one side.

d. Insert a JAN type BA-30, 1.5 volt dry cell, into the trough on chassis H-101. Insert the bottom of the battery (its negative polarity) first.

e. Turn contact E-118 back into position so its extruded contact point presses against the positive battery post in the center of the top of the dry cell.

f. Hold the terminal for the black wires so they do not project out over the edge of chassis H-101, and tighten the screw which holds contact E-118 and the terminal to chassis H-101. When the screw is tight, contact E-118 will not only connect the positive battery polarity to chassis ground in the instrument, but will also hold the battery in its trough.

g. Return the instrument to its case. Be careful to slip the rubber gasket under the edge of the case all the way around, and to prevent any damage to the gasket. This is the seal which makes the instrument watertight when the cover is clamped in place.

h. Fasten the front panel in its case with the four large binder head screws which you removed in step *a* above. Be sure that the instrument is placed in the case right side up. The handle is on the top of the case, and meter M-101 is at the top of the front panel.

4. OPERATING LOCATION.

Multimeter ME-25B/U is completely self contained and portable for measurements of direct currents only. For any voltage or resistance measurement, its operating location must be close to a source of power. The instrument requires 105 to 125 volts, single phase AC, 50 to 1000 cycles, and consumes 13 watts of power while it is turned on. Power cord W-105 is eight feet long, including the part which is inside the instrument. This determines the maximum distance between a power outlet and the instrument when it is used for voltage and resistance measurements. The meter will work well in any operating position, although it is characteristic of all electrical indicating meters with high sensitivity to exhibit less pivot friction when the pivots are vertical. For this condition, lay Multimeter ME-25B/U on its back while you make any measurements.

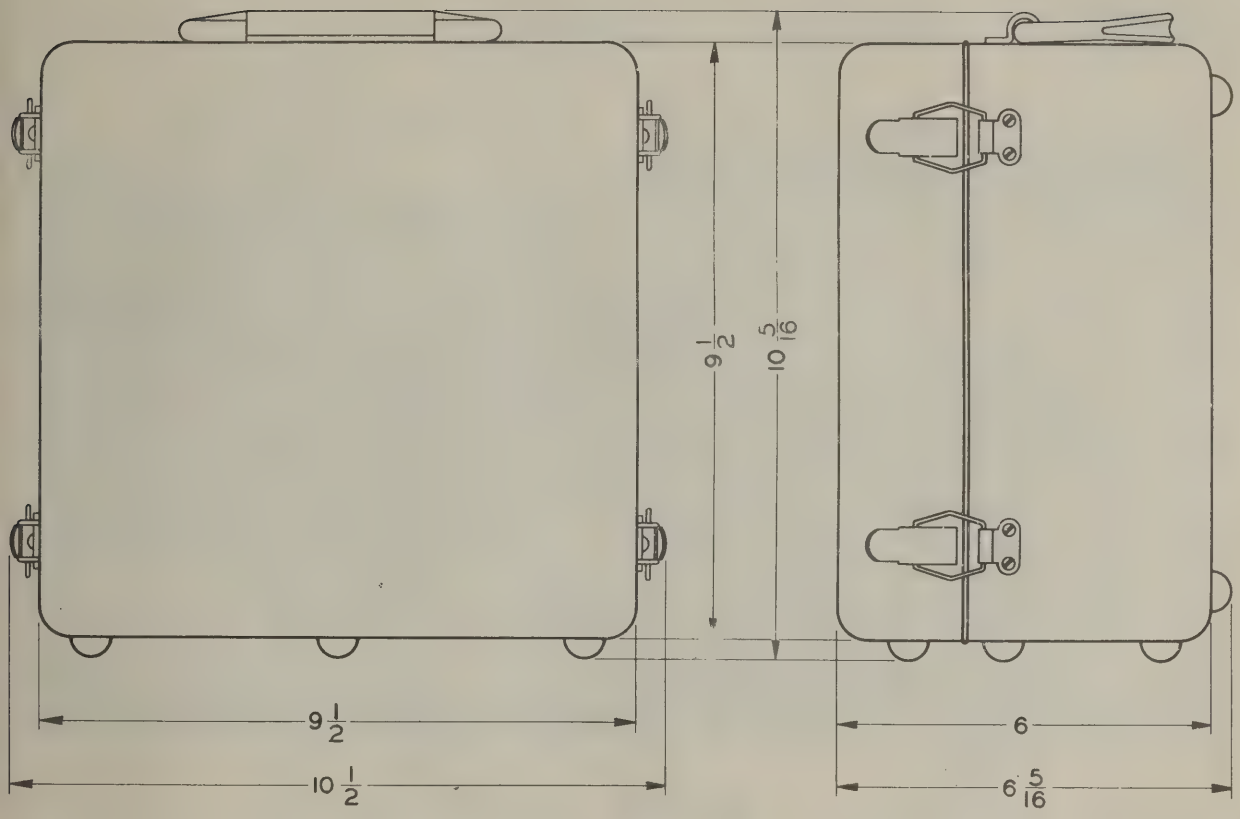


Figure 3-1. Outline Drawing of Multimeter ME-25B/U.

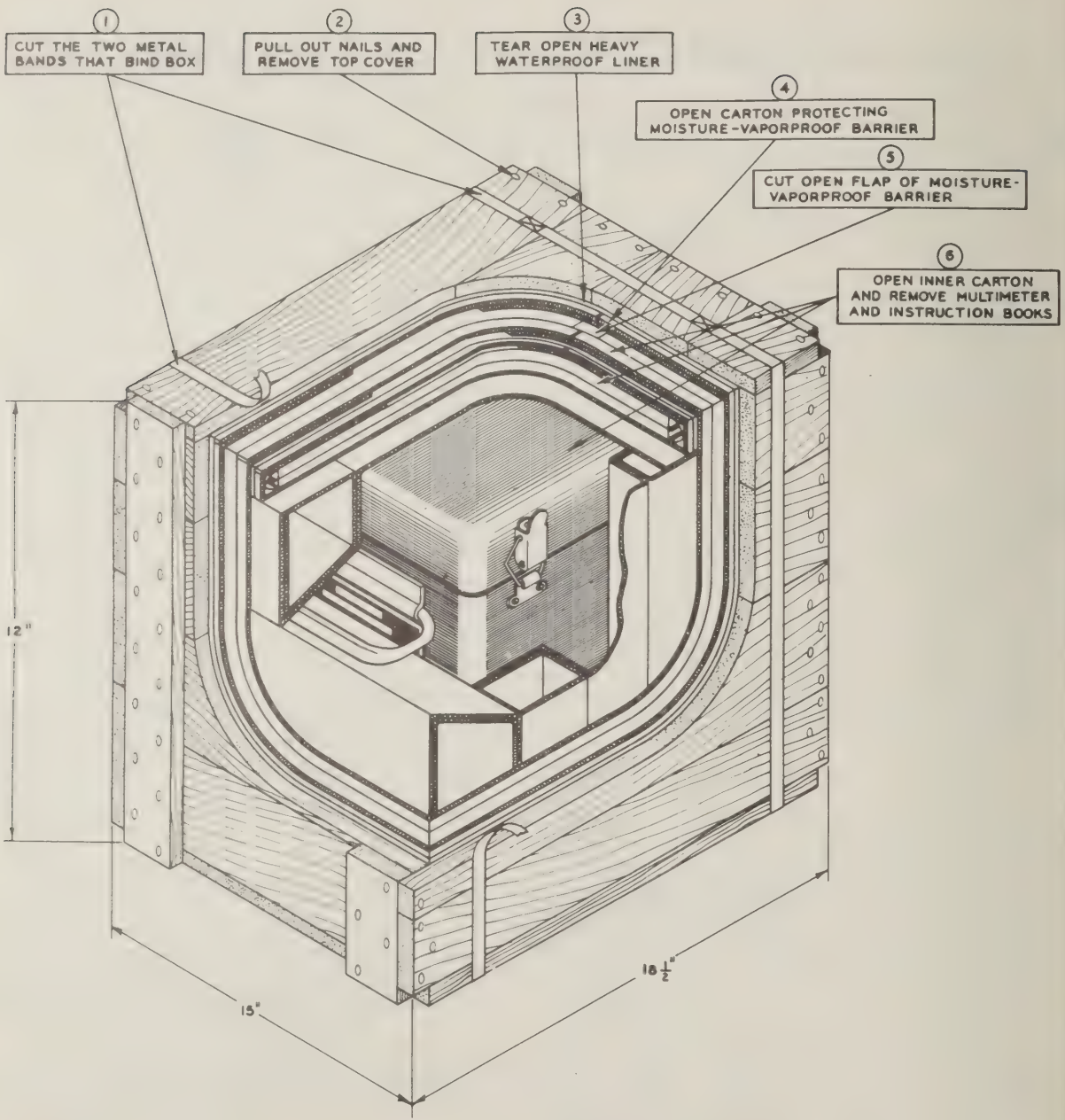


Figure 3-2. Cutway View of Export Packing.

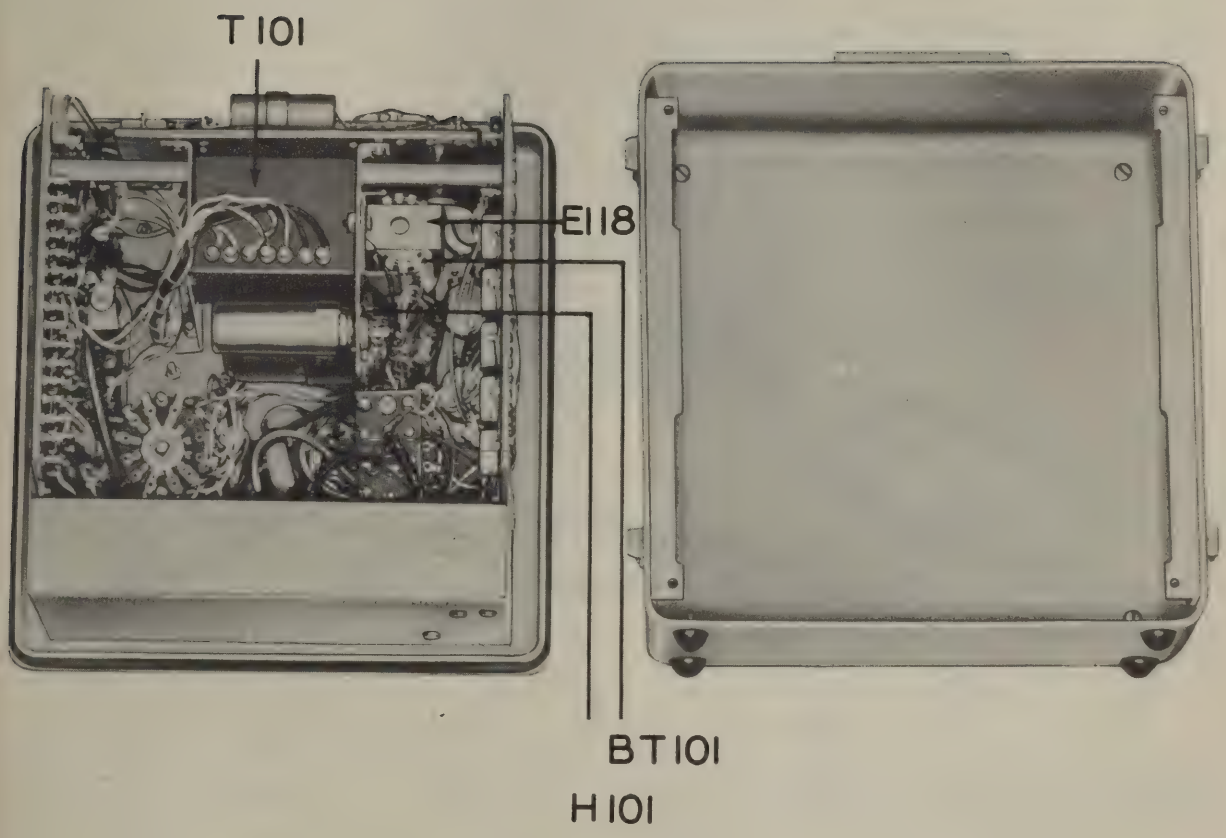


Figure 3-3. Location of Battery BT-101.

SECTION 4
OPERATION

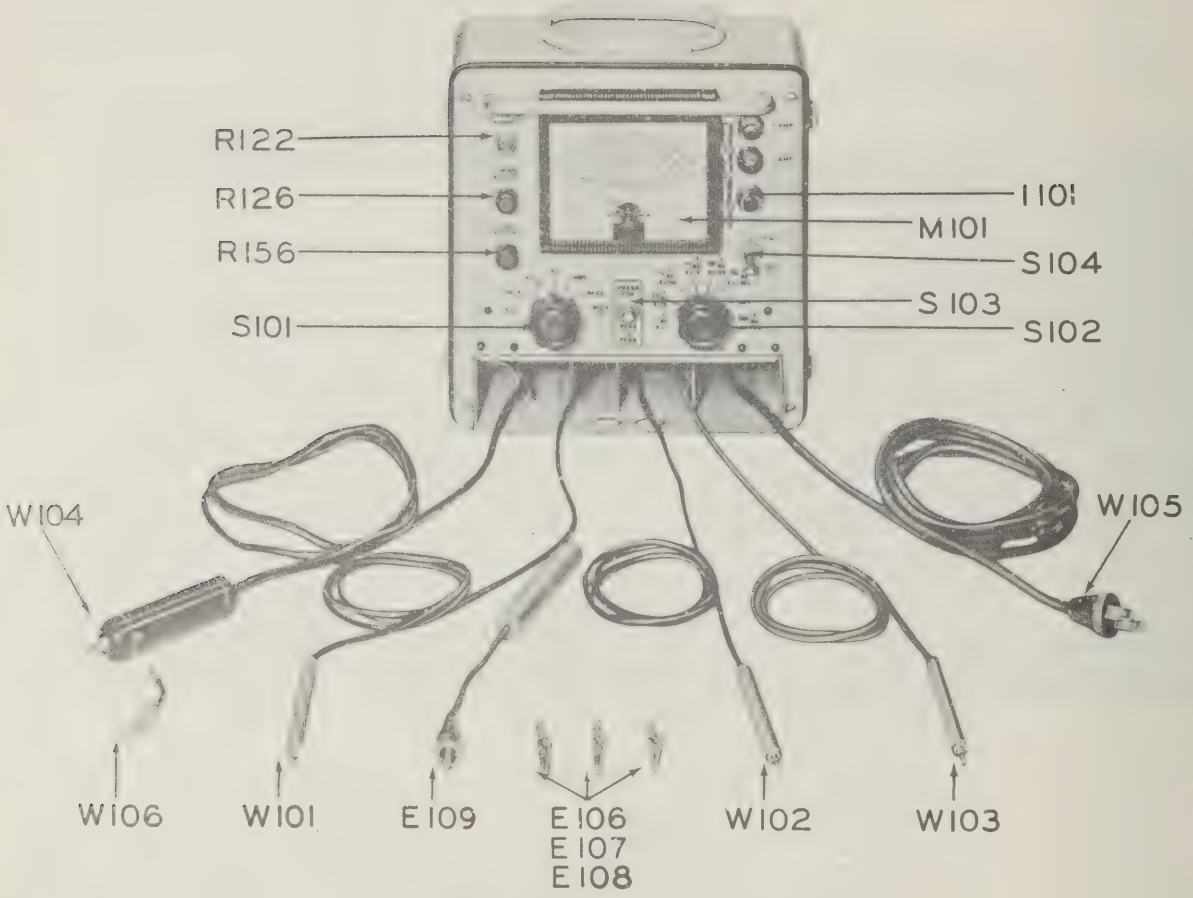


Figure 4-1. Multimeter ME-25B/U; Front Panel Control, Leads, and Accessories.

1. FUNCTIONS OF EQUIPMENT.

Multimeter ME-25B/U is designed to permit the service technician to make voltage, resistance, and current measurements within a wide range of values with only one piece of test equipment. DC voltages as high as 1000 volts can be measured with the basic circuits; the range is extended to 5000 volts with the use of high voltage probe extension E-109. AC and RF voltages with frequencies from 50 cycles through 100 megacycles can be measured in terms of either their RMS or their peak-to-peak values up to 100 volts. AC voltages with frequencies from 50 cycles up to 50 kilocycles can be measured in terms of RMS or peak-to-peak values up to 1000 volts. Resistances can be measured which have any values in the range from a fraction of an ohm through 1000 megohms. DC currents can be measured from approximately two microamperes through 1000 milliamperes (one ampere).

2. CONTROLS AND THEIR FUNCTIONS.

a. POWER SWITCH S-104.—This is a double pole single throw toggle switch which opens and closes the power input circuit. Setting this switch at its ON

position applies the power supply voltage when line cord W-105 is connected to the 105 to 125 volt source. The power switch may be in either ON or OFF position for current measurements, but needs to be ON for voltage or resistance measurements. At any time when power is on for the instrument, red pilot lamp I-101 will light.

b. FUNCTION SWITCH S-101.—This switch determines which type of measurement the internal circuits of Multimeter ME-25B/U are prepared to make. It has seven positions, each of which indicates the kind of measurement that can be made. The position names and their associated functions are:

(1) —D.C.V. Direct current voltages in any range selected with range switch S-102 can be measured with probes W-101 and W-103. Probe W-101 contacts negative polarity and probe W-103 contacts positive polarity to obtain a reading in this switch position.

(2) +D.C.V. Direct current voltages in any range selected with range switch S-102 can be measured with probes W-101 and W-103. Probe W-101 contacts positive polarity and probe W-103 contacts negative polarity to obtain a reading in this switch position.

(3) A.C. Alternating current voltages in any range selected with range switch S-102 can be made with probes W-102 and W-103, or up to 100 volts with probes W-104 and W-103 or with probes W-104 and W-106. The polarity of the input will not matter. The frequency range for this switch position is 50 cycles through 50 kilocycles.

(4) R.F. Voltages at frequencies up through 100 megacycles can be measured with the switch in this position. Probe W-104 contacts the signal source, and its screw-on ground lead, W-106, contacts the ground return of the signal. The voltage range is limited to 100 volts for this circuit.

(5) OHMS. Resistance values in ohms can be measured with switch S-101 in this position. The smallest marked value of resistance is 0.2 ohm, and the largest is 1000 megohms. Ranges are obtained with range switch S-102. Probes W-102 and W-103 are used to contact the measured resistance.

(6) MA-D.C. Direct current values can be measured from about 20 microamperes up to a maximum of 1000 milliamperes (one ampere). Probes W-102 and W-103 are the test leads for this circuit.

(7) 100 uA-D.C. Direct current values in the range from 2 to 100 microamperes can be measured with switch S-101 in this position. There is no connection to range switch S-102 for this position of S-101, and the range is established automatically. Probes W-102 and W-103 are the test leads for this circuit.

c. RANGE SWITCH S-102.—This switch determines what value of the electrical characteristic being measured will cause full scale deflection of meter M-101. It has eight positions which are named and used as follows:

(1) 1V MA Rx1.

(a) With switch S-101 at —D.C.V. or at +D.C.V., 1 volt DC is necessary to cause full scale deflection. Read the value on the 0 to 10 range of meter M-101, and divide by 10.

(b) With switch S-101 set at either A.C. or R.F., 1 volt AC or RF will cause full scale deflection. Read the value on the purple-blue arc marked 1 V.A.C. ONLY.

(c) With switch S-101 set at OHMS, read the resistance value directly on the green scale at the top of the meter dial.

(d) With switch S-101 set at MA-D.C., 1 milliampere DC will cause full scale deflection. Read the current value on the 0 to 10 scale of the meter and divide by 10.

(2) 2.5V MA Rx10.

(a) With switch S-101 set at —D.C.V., +D.C.V., A.C., or R.F., 2.5 volts are necessary to cause full scale deflection. Read the value on the 0 to 250 scale of the meter and divide by 100.

(b) With switch S-101 set at OHMS, read the resistance value on the green scale at the top of meter M-101, and multiply this by 10.

(c) With switch S-101 set at MA-D.C., 2.5 milliamperes DC are necessary to cause full scale meter deflection. Read the value on the 0 to 250 scale of the meter, and divide by 100.

(3) 10 V MA Rx100.

(a) With switch S-101 set at —D.C.V., +D.C.V., A.C., or R.F., 10 volts are necessary to cause full scale meter deflection. Read the value directly on the 0 to 10 scale of meter M-101.

(b) With switch S-101 set at OHMS, read the resistance indicated on the green scale at the top of the meter, and multiply by 100.

(c) With switch S-101 set at MA-D.C., 10 milliamperes DC will cause full scale deflection. Read the value of current directly on the 0 to 10 range of the meter.

(4) 25 V MA Rx1K.

(a) With switch S-101 set at —D.C.V., +D.C.V., A.C., or R.F., 25 volts are necessary to cause full scale deflection. Read the value of voltage on the 0 to 250 scale and divide by 10.

(b) With switch S-101 set at OHMS, read the resistance value on the green scale at the top of meter M-101, and multiply this by 1000 for ohms.

(c) With switch S-101 set at MA-D.C., 25 milliamperes are necessary for full scale deflection. Read the value on the 0 to 250 scale of the meter, and divide by 10.

(5) 100 V MA Rx10K.

(a) With switch S-101 set at —D.C.V., +D.C.V., A.C., or R.F., 100 volts will cause full scale deflection. Read the value on the 0 to 10 range of the meter, and multiply by 10.

(b) With switch S-101 set at OHMS, read the resistance indicated on the green scale at the top of the meter, and multiply this by 10,000 for ohms.

(c) With switch S-101 set at MA-D.C., 100 milliamperes DC will cause full scale meter deflection. Read the value on the 0 to 10 scale and multiply this by 10 for milliamperes.

(6) 250 V MA Rx1MEG.

(a) With switch S-101 set at —D.C.V., +D.C.V., or A.C., 250 volts will cause full scale deflection. Read the voltage directly on the 0 to 250 scale of meter M-101.

(b) With switch S-101 set at OHMS, read the value indicated on the green scale at the top of meter M-101. The reading can be interpreted directly as megohms, or may be multiplied by 1,000,000 for the number of ohms.

(c) With switch S-101 set at MA-D.C., 250 milliamperes DC will cause full scale deflection. Read the value indicated on the 0 to 250 scale of the meter directly for milliamperes.

(7) 500 V.

(a) With switch S-101 set at —D.C.V., —D.C.V., or A.C., 500 volts are necessary to cause full scale meter deflection. Read the value on the 0 to 50 scale of the meter and multiply by 10.

(b) With switch S-101 set at MA-D.C., 500 milliamperes DC will cause full scale deflection. Read the value on the 0 to 50 scale and multiply by 10.

(8) 1000 V MA 5000 V.D.C.

(a) With switch S-101 set at —D.C.V. or +D.C.V., and using test leads W-101 and W-103, 1000 volts DC is necessary to cause full scale meter deflection. Read the indication on the 0 to 10 scale of the meter and multiply by 100.

(b) With switch S-101 set at —D.C.V. or —D.C.V., and using extension E-109 screwed on over W-101 for one test lead and W-103 for the other lead, 5000 volts will cause full scale deflection. Read the indication on the 0 to 50 scale of the meter and multiply by 100.

(c) With switch S-101 set at A.C., 1000 volts AC will cause full scale deflection. Read the indication on the 0 to 10 scale of meter M-101 and multiply by 100.

(d) With switch S-101 set at MA-D.C., 1000 milliamperes DC (the same as 1 ampere DC) will cause full scale meter deflection. Read the indication on the 0 to 10 range of meter M-101, and multiply it by 100 for milliamperes, or divide it by 10 to obtain the fraction of one ampere.

d. PRESS FOR PEAK TO PEAK SWITCH S-103.—When you measure AC or RF sine wave voltages with Multimeter ME-25B/U, it is possible to obtain values for both the RMS and Peak-to-peak quantities of voltage. The nature of the input circuit is such that the input voltage is rectified with tube V-101, and the peak-to-peak value of this input voltage is applied through a long time constant circuit to the DC divider network. A portion of the applied voltage is selected with range switch S-102, and is applied to the signal grid of the bridge tube, V-103. This voltage is proportional to the peak-to-peak voltage of the applied AC or RF input. The meter deflection which normally results from this applied voltage is an indication of the RMS value. When you press the PRESS FOR PEAK TO PEAK switch, S-103, you short out part of the resistance in series with meter M-101. This provides more deflection for the same voltage input. The ratio of the first deflection to the second is the same as the ratio of RMS to Peak-to-peak values of a sine wave voltage, which is 1 to 2.828. Usually, this will be enough deflection to drive the meter pointer off scale unless range switch S-102 is set at its next higher position. The reading on the meter scale with switch S-103 pressed in is the numerical value of peak-to-peak voltage in the input signal. The peak-to-peak indication is correct for all wave shapes of input voltages, providing they have a duty cycle of at least 4×10^{-6}.

e. ZERO ADJUST CONTROL R-156.—When function switch S-101 is in any position in which the instrument will use bridge tube V-103, ZERO ADJUST control R-156 provides for electronic balance of the bridge circuit with no signal voltage applied. With no voltage applied (or for OHMS readings, with probes W-102 and W-103 shorted together), the signal grid of tube V-103, pin 1, is at ground potential. The setting of ZERO ADJUST control R-156 shifts the value of voltage applied to the other tube grid around ground potential to balance the bridge circuit and obtain a zero indication on meter M-101.

f. OHMS ADJUST CONTROL R-126.—When function switch S-101 is set at OHMS and the test probes, W-102 and W-103, are separated by an infinite resistance, the meter should read full scale for infinity. The OHMS ADJUST control, R-126, will change the sensitivity of the meter circuit so that meter M-101 will

read full scale with the voltage applied from battery BT-101. As the battery ages, it will tend to become weaker and will furnish less voltage to cause meter deflection; control R-126 compensates for this variation over a long period of battery life. When the meter can no longer be made to read full scale with the adjustment of R-126, this indicates that battery BT-101 needs to be replaced.

g. CONTACT POTENTIAL ADJUST R-122.—When you set function switch S-101 at A.C. or at R.F., the input voltage is rectified by tube V-101 in diode probe W-104. Even when there is no applied voltage, tube V-101, with its heated cathode, causes a small current to flow through the voltage divider circuit, so a small signal is applied to the signal grid of bridge tube V-103. This current is due to Edison Effect in tube V-101. The voltage which it furnishes to the divider network is negative. The setting of CONTACT POTENTIAL ADJUST control R-122 determines the amount of positive voltage which is applied to the divider network. When the amount is equal to the amount of negative voltage due to Edison Effect, it counteracts the voltage applied to the divider network and eliminates deflection of meter M-101. After the ZERO ADJUST control has been properly set with switch S-101 at —D.C.V. or at +D.C.V., set switch S-101 at A.C. If there is a deflection in the A.C. position, set CONTACT POTENTIAL ADJUST control R-122 to eliminate the deflection. It is a screwdriver control because its setting is dependent on the internal condition of tube V-101, which will not change noticeably over a long period of time, and it should not need to be reset frequently.

h. FUSES F-101, F-102, F-103, and F-104.—Fuses F-101 and F-102 are in the primary circuit for transformer T-101, to protect the transformer if an overload should develop in any of the electronic circuits of Multimeter ME-25B/U. Fuses F-103 and F-104 are identical to F-101 and F-102, and are to be used as spares for the line fuses if either or both should blow out. If F-101 or F-102 should blow out, determine and eliminate the cause of the overload, and then replace with F-103 or F-104.

i. PROBES AND TEST LEADS W-101, W-102, W-103, W-104, W-106.—These are all stored in the test lead compartment at the bottom of the front panel on Multimeter ME-25B/U.

(1) W-101.—This is a heavy black lead with a brown probe handle and a sharp pointed probe tip. It is used for all DC voltage measurements. The lead is heavy because it has a shield braid surrounding the wire to eliminate any stray signal from being picked up in the lead. The instrument end of the lead is soldered to a terminal on terminal board TB-104, and the shield braid is connected to ground on the same terminal board. Inside the probe there is a 5 megohm resistor, R-102, which is an isolating resistor and is part of the voltage divider network for DC voltages.

(2) W-102.—This is a red test lead which is used for all resistance and current measurements, and may be used for AC voltage measurements. If the AC voltage being measured has a strength of over 100 volts, test lead W-102 must be used; but if the measured voltage does not have that much strength, either test lead W-102 or W-104 may be selected optionally. The instrument end of this lead is soldered in place at a terminal on terminal board TB-104. The probe end has a brown probe handle and a sharp pointed tip.

(3) W-103.—This light weight black test lead is the return lead for all voltage, resistance, and current measurements. It is grounded for voltage and resistance ranges, but is not grounded for current. The instrument end of the lead is soldered in place on terminal board TB-104. The probe end has a brown probe handle and a sharp pointed tip.

(4) W-104.—This is the large diode test probe which has a black covered lead, and a housing at the probe end in which diode tube V-101 is located. Any AC or RF voltage which is being measured with Multimeter ME-25B/U is rectified in the handle of W-104. Its peak-to-peak DC value is then connected to the instrument through the test lead and provides the measurable signal for the voltage divider network. The probe handle has a convenient receptacle on its side near the probe tip, where ground return lead W-106 can be screwed in place. W-106 should be used as the ground return for all RF voltage measurements. The maximum signal strength which can be measured is 100 volts. This combination of W-104 and W-106 can also be used to measure AC voltages up to 100 volts if the operator desires to do so. Since the diode rectifier tube is in the probe handle of W-104, and it is used for all AC voltage measurements whether they are contacted by the probe tip of W-104 or by W-102, this probe must be in place in lead compartment A-105 at all times when you are not actually using it to contact a signal voltage. When it is in place in the lead compartment, its tip contacts jack J-101 so that any signal contacted by probe W-102 will furnish a voltage to the diode for rectification.

NOTE

Always replace probe W-104 in the lead compartment when it is not in use. Its tip must be seated in Jack J-101 to allow AC voltage measurements to be made.

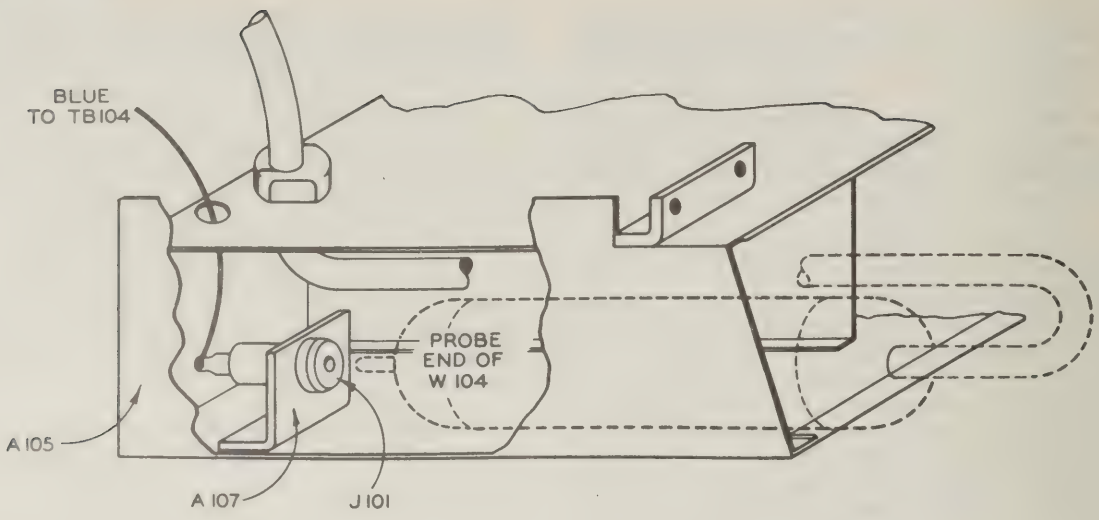


Figure 4-2. Position of Diode Probe W-104 in Lead Compartment A-105.

(5) W-106.—This short screw-on ground return is essential for RF voltage measurements, and may be used for AC voltage measurements. It has a crocodile clip for the probe end, and a threaded connector at the other end. The short piece of test lead is black. The connector screws in place in the receptacle on the side of the W-104 probe handle mentioned in paragraph (4) above. When you return diode probe W-104 to the lead compartment, unscrew lead W-106 and store it in the lead compartment for use at a later time again.

j. ACCESSORIES E-106, E-107, E-108, E-109.—These accessories are all stored in the test lead compartment when they are not in use.

(1) E-106, E-107, and E-108. — These are three alligator clips which are interchangeable in the sense that they are all made the same. They have internally threaded bushings which will fit over the threaded shoulders on the tips of test leads W-101, W-102, and W-103. If you need a clip connection on any of these leads, remove an alligator clip from the test lead compartment and screw it in place over the tip of the test lead. The clip may be left screwed in place over the end of the probe until the cover of Multimeter ME-25B/U is to be closed; then you will have to remove it in order to pull the cover into position over the face of the meter.

(2) E-109.—This is the high voltage DC extension with the red plastic handle and the red test lead. It screws on over the end of test lead W-101 and then multiplies the range of Multimeter ME-25B/U for DC voltages to 5 times the amount which is set with range switch S-102. Its main use is on the 5000 volt DC range; set range switch S-102 at the full clockwise position marked 1000 V MA 5000 V.D.C. Actually, the internal circuit of the instrument is set for 1000 volts DC, and it is only the addition of extension E-109 on the end of test lead W-101 which will complete the circuit for the 5000 volt range. A 200 megohm resistor, R-101, is inside the handle of E-109, and this is added in series with the regular 50 megohm DC input circuit in the instrument to multiply the range by 5. With extension E-109 on test lead W-101, all DC voltage ranges are multiplied by 5.

k. POWER LINE CORD W-105.—This is a two-conductor rubber covered line cord with a power plug at the end for use in connecting the instrument to a power source. Power must be supplied from a 105 to 125 volt, single phase, 50 to 1000 cycle source for all voltage and resistance measurements. This will furnish the power to operate the electronic bridge circuit for these measurements. The instrument end of lead W-105 is soldered in place on terminals of terminal board TB-104.

3. PRELIMINARY OPERATION.

a. All the probes and cables, including the power line cord, are stored inside the lead compartment at the bottom of the front panel of Multimeter ME-25B/U. Sufficient space is included in this compartment to store test leads W-101, W-102, W-103, W-104, and W-106, power line cord W-105, and accessories E-106, E-107, E-108, and E-109. These are all shown in figure 4-1.

b. Zero the meter indication before any power or signal is applied to the instrument. Adjust the zero set screw in the face of the meter (see figure 4-1) until the meter pointer rests over zero at the left hand side of the meter.

c. Connect the power line cord, W-105, to a source of 105 to 125 volts, single phase, 50 to 1000 cycles AC power.

d. Set power switch S-104 to its ON position. Pilot lamp I-101 should light to indicate that power is applied. After a short warm up time, the meter pointer will normally be deflected and then come back to rest at zero again if function switch S-101 is set at a voltage or resistance position. Allow about three minutes for the tubes to heat sufficiently to allow the instrument to stabilize. During its period of use, leave the power on; it requires only 13 watts, and you will eliminate warm up time for repeat uses. Do not leave the function switch at OHMS except while you are actually measuring resistance.

4. WARNINGS.

Be sure to use the following warnings when you are using this equipment.

WARNING

Voltages over 300 volts shall be measured as follows:

(1) Deenergize the equipment. Ground terminals to be measured to discharge any capacitors connected to these terminals (see note F).

(2) Connect the meter to terminals to be measured, using a range higher than the expected voltage.

(3) WITHOUT TOUCHING THE METER OR THE TEST LEADS, energize the equipment and read the meter.

(4) Deenergize the equipment. Ground the terminals connected to the meter before you disconnect the meter.

NOTES

(A) MAKE SURE you are NOT GROUNDED whenever you are adjusting equipment or using measuring equipment.

(B) In general, USE ONE HAND ONLY when servicing live equipment.

(C) If test meter must be held or adjusted while voltage is applied, connect the ground return, W-103 or W-106, first before you start to measure, and do not touch the live equipment while you are holding the meter.

(D) DO NOT FORGET that high voltages MAY BE PRESENT across terminals that are normally low voltage, due to equipment breakdown. Be careful even when measuring low voltages.

(E) DO NOT use test equipment which is known to be in poor condition.

(F) High voltage capacitors should be discharged with a grounding stick with approximately 10 ohms in series with the grounded line. Where neither terminal is grounded, short the capacitor terminals to each other.

(G) The attention of officers and operating personnel is directed to chapter 67 of Bureau of Ships Manual or superceding instructions on the subject of radio-safety precautions to be observed.

5. CHECK LIST FOR PROBES.

Use the following check list to select the appropriate pair of probes for use on each type of measurement with Multimeter ME-25B/U. See figure 4-1 to identify the probes.

TABLE 4-1. SELECTION OF PROPER PROBES.

CORRECT PROBES	DC VOLTS		AC VOLTS		RF VOLTS	OHMS	DIRECT CURRENT
	UP TO 1000 V	UP TO 5000 V	UP TO 100 V	UP TO 1000 V			
W-101 and W-103	X						
W-101 with E-109 and W-103		X					
W-102 and W-103			X	X		X	X
W-104 and W-103			X				
W-104 and W-106			X		X		

6. DC VOLTAGE MEASUREMENTS.

a. Set power switch S-104 at ON and allow time for the instrument to warm up.

b. Set function switch S-101 at +D.C.V.

c. Set range switch S-102 for the range of voltage which is to be measured. If in doubt, set it for a high range and reduce the setting during the following steps if the voltage is within a lower range.

d. If the voltage to be measured is between 1000 and 5000 volts DC, screw high voltage probe extension E-109 over test lead W-101. Set range switch S-102 fully clockwise at the position marked 1000 V MA 5000 V.D.C.

e. Check the electronic bridge circuit balance with no voltage applied to the test leads. If necessary, set the ZERO ADJUST control, R-156, for a zero indication on the meter.

f. Connect test lead W-103 to the ground side of the voltage which is to be measured. If neither side is grounded, attach the probe at the point which is nearer ground potential.

g. Observe warnings in paragraph 4 above, and connect test lead W-101 (or extension E-109 if it has been screwed on over W-101) to the high potential point to be measured.

h. If the meter tends to read in reverse, turn off the voltage and set function switch S-101 at —D.C.V. Then turn on the voltage again for a reading. This indicates that the heavy lead, W-101, is connected to the negative source of voltage, and the return lead, W-103, is contacting the positive polarity.

i. Read the value of voltage on the meter scale. For DC volts, use the arc marked VOLTS MA uA. Note that this arc has three sets of numerical values. The position of range switch S-102 indicates the amount of voltage which would cause full scale deflection, and the proper arc of numerical markings to use.

j. The total impedance of the input circuit for DC voltage measurements is 50 megohms without probe extension E-109, or 250 megohms with the probe extension.

k. Observe the precautions in paragraph 4 above when you disconnect the probes from the circuit under test.

7. AC VOLTAGE MEASUREMENTS.

a. Set power switch S-104 at ON and allow time for the instrument to warm up.

b. Set function switch S-101 at +D.C.V. and set ZERO ADJUST control R-156 for a zero indication on meter M-101.

c. Set function switch S-101 at A.C. Observe the meter: if it does not read zero, set CONTACT POTENTIAL ADJUST for a zero reading.

d. Set range switch S-102 for the range of voltage which you are going to measure. If in doubt, set it for a high range and reduce this setting during the following steps if the voltage is within a lower range.

e. If there is any possibility of the measured voltage having a strength greater than 100 volts RMS, seat the diode probe, W-104, firmly in position in the lead compartment so its tip contacts jack J-101. Then use test leads W-102 and W-103 to contact the source to be measured. If the voltage is less than 100 volts RMS, you may use diode probe W-104 to contact the source of voltage in the following steps rather than test lead W-102. This is optional at frequencies below 50 kilocycles, and the same readings will be obtained with the use of either probe.

f. Connect test lead W-103 to the ground side of the voltage source, or to the side nearer ground potential if neither side is grounded. If you are going to use diode probe W-104, you may use its ground lead, W-106, for this connection rather than W-103; this is optional.

g. Connect test lead W-102 to the "hot" side of the voltage source.

CAUTION

Do not hold test leads while connecting voltages in excess of 300 volts. Connect and disconnect the leads while the equipment is turned off.

h. Read the RMS value of the measured voltage on the meter scale. If range switch S-102 is set at 1 V MA Rx1, use the purple-blue arc of the meter scale marked 1 V.A.C. ONLY. If any other range is used, read the arcs marked VOLTS MA uA. This arc has three sets of numerical values. The position of range switch S-102 indicates which set to use.

i. If the Peak-to-peak value of the applied voltage is desired, press the PRESS FOR PEAK TO PEAK switch, S-103, while you make the reading. Range switch S-102 will usually have to be set at the next higher position, since the peak-to-peak value is 2.828 times as much as the RMS indication, and this will be enough to drive the meter pointer off the scale unless the RMS indication is within about the left hand third of the scale.

8. DECIBEL MEASUREMENTS.

Power levels are measured in decibels (DB). If a constant impedance value is used as a reference, there is a relationship between power levels and AC voltage levels. Decibel values are marked on the dial of Multimeter ME-25B/U, and these values assume that a reference of 1 milliwatt across a 600 ohm impedance is zero decibels. The basic range shown on the meter is —12 to +10 DB, and is used with the 2.5 volt AC range. If the voltage is higher, the decibel level is also higher, and information on the meter dial indicates how many decibels to add to the reading on the meter for 10, 25, and 100 volt AC ranges.

a. Use the following steps to make decibel readings when the voltage is read across a 600 ohm impedance load:

(1) Follow the information in paragraph 7 above to make an AC voltage measurement.

(2) Note the setting of range switch S-102 when you have a satisfactory deflection for voltage measurement. If this switch is in the 1 V MA Rxl position, set it at the 2.5 V MA Rx10 position to measure decibels.

(3) Read the decibel scale on the dial of meter M-101.

(a) If switch S-102 is in the 2.5 V MA Rx10 position, the DB reading is correct as read on meter M-101.

(b) If switch S-102 is in the 10 V MA Rx100 position, add +12 DB to the reading on the meter for the correct decibel level.

(c) If switch S-102 is in the 25 V MA Rx1K position, add +20 DB to the reading for the correct decibel level.

(d) If switch S-102 is in the 100 V MA Rx10K position, add +32 DB to the meter reading for the correct decibel level. +42 DB is the highest level in the range of Multimeter ME-25B/U.

b. If the load impedance across which the voltage is being read is other than 600 ohms, the decibel level must be established with the formula:

$$DB = 10 \log_{10} \frac{P_1}{P_2}$$

where DB = power level above or below reference level,
P_1 = power being measured,
and P_2 = power in the reference level.

To obtain P_1 for the above formula, make the following calculation:

$$P_1 = \frac{E^2}{R}$$

where E = RMS value of AC voltage
and R = impedance value of the load.

c. If the reference level is .006 watts across 500 ohms, subtract 7 DB from the reading which you make in paragraph *a* above.

9. RF VOLTAGE MEASUREMENTS.

a. Set power switch S-104 at ON and allow time for the instrument to warm up.

b. Set function switch S-101 at +D.C.V. and set ZERO ADJUST control R-156 for a zero indication on meter M-101.

c. Set function switch S-101 at R.F. Observe the meter; if it does not read zero, set CONTACT POTENTIAL ADJUST for a zero reading.

d. Set range switch S-102 for the range of voltage which you are going to measure. If in doubt, set it for a higher range than expected (100 volts maximum) and reduce the setting during the following steps if the voltage is within a lower range.

e. Use diode probe W-104 to measure RF voltages. Use ground return lead W-106, screwed in place in the receptacle at the side of the rectifier housing near the tip of probe W-104, to contact ground potential of the measured voltage. Connect the clip at the end of ground lead W-106 to the chassis or to a ground point near the source of RF voltage which you are to measure.

f. Contact the source of voltage with the tip of diode probe W-104.

CAUTION

Do not contact any source of RF voltage in excess of 100 volts with probe W-104. The probe may be damaged.

g. If the wave form of the contacted voltage is a pure sine wave, read its RMS value on the indicated meter scale. If its peak-to-peak value is desired, press the PRESS FOR PEAK TO PEAK switch, S-103, and read this value on the meter scale.

h. If the wave form of the contacted voltage is not a sine wave, disregard the RMS indication except for a relative value. Press the PRESS FOR PEAK TO PEAK switch, S-103, to obtain an absolute value for the voltage which you are measuring. Multimeter ME-25B/U indicates peak-to-peak values for non-sinusoidal wave shapes, but does not indicate true RMS values for these types.

i. Peak-to-peak values of pulse type wave forms which are repeated at regular intervals to provide a frequency within the range of Multimeter ME-25B/U are essentially correct, providing that the duty cycle is at least 4×10^{-6} of the cycle time.

10. RESISTANCE MEASUREMENTS.

a. Set power switch S-104 at ON and allow time for the instrument to warm up.

b. Set function switch S-101 at OHMS.

c. Short test leads W-102 and W-103 together and observe meter M-101; it should read zero. If it does not, set the ZERO ADJUST control, R-156, for a zero reading.

d. Separate the test leads, W-102 and W-103. Observe meter M-101; it should indicate full scale, which is marked ∞ on the green OHMS arc. If it does not, set the OHMS ADJUST control, R-126, for a full scale deflection.

e. Be sure that no power is connected to the resistor or circuit in which you are going to make a resistance measurement, and that there is no voltage across it.

f. Contact the two points between which you wish to measure the resistance. Use test leads W-102 and W-103. If there is any difference between the forward and backward resistance within the circuit, such as in a copper oxide rectifier, consider the polarity of the test leads. The black lead, W-103, is connected to positive battery polarity, and red test lead W-102 is connected to negative polarity.

g. Set range switch S-102 to a position which gives a readable deflection of the pointer. If you can get a readable indication on two or more ranges, use the one which gives the reading nearest the center of the scale.

h. Read the OHMS value on the green arc at the top of the meter.

(1) If the range switch is set at 1 V MA Rx1, the value read on the green arc indicates the amount of resistance between the test leads.

(2) If range switch S-102 is set at 2.5 V MA Rx10, or any of the other four resistance range positions, multiply the reading on meter M-101 by the value indicated at the range switch position to determine the number of ohms of resistance between the test probes.

11. MILLIAMPERE MEASUREMENTS.

a. Multimeter ME-25B/U does not need to have power on for current measurements, but if the power is on, it will not interfere with any of the measurements.

b. Set function switch S-101 at MA-D.C.

c. Set range switch S-102 to a position which will be a high enough range for the current which you are going to measure. If you are in doubt as to the strength of the current, set range switch S-102 to its highest position and reduce the setting during the following steps if the current value is within the lower range.

d. Open the circuit to be measured and place the meter in series with the circuit.

CAUTION

Do not connect any current measuring device across a voltage source without a protective resistance in series with it. Any normal operating circuit will furnish this protective resistance when you connect the meter in series with it.

e. Connect test lead W-102 to the point in the circuit which is on the positive potential side, and test lead W-103 to the point which is on the negative side.

g. Read the value of current on the meter scale indicated by the position of range switch S-102. Read the arcs marked VOLTS MA uA.

12. MICROAMPERE MEASUREMENTS.

a. Use the procedure outlined in paragraph 11 above for measuring milliamperes. If the indicated current is less than 0.1 milliampere, it is within the range of Multimeter ME-25B/U for microampere measurements. Proceed as follows.

b. Turn function switch S-101 to its 100 uA-D.C. position. Range switch S-102 is not in the circuit for this position of function switch S-101.

c. Read the value on the 0 to 10 scale of meter M-101 and multiply the value indicated on the meter by 10 for microamperes.

SECTION 5
OPERATOR'S MAINTENANCE

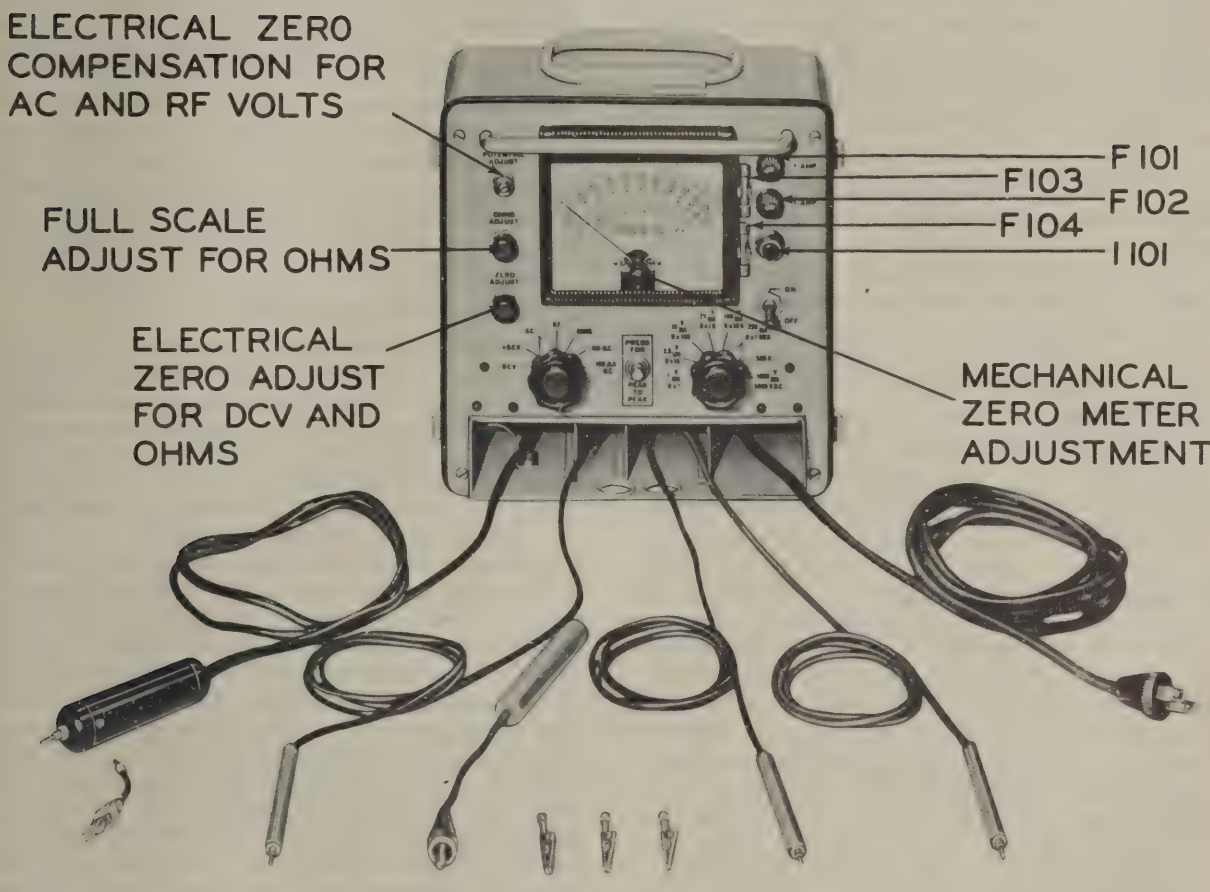


Figure 5-1. Multimeter ME-25B/U, Front Panel.

1. ZERO SETTING.

Meter M-101 should read zero when there is no signal input for voltage and current readings, and also when the test leads are shorted together for resistance readings. When the meter does not read zero, the variation may be caused by either a mechanical or an electrical change. It can be because there has been a change in the meter itself. It may be caused by an electronic unbalance in the bridge circuit, or when the voltage tapped with the CONTACT POTENTIAL ADJUST control does not exactly match the amount of voltage due to Edison Effect on AC or RF voltage measurements. To correct for an off-zero indication on meter M-101, use the following steps:

a. MECHANICAL.—Set function switch S-101 at MA-D.C., or at 100 uA-D.C. Observe the indication on meter M-101 with no signal connected to test leads W-102 and W-103. If it does not indicate zero, use a small screwdriver to turn the zero setting adjuster at the center of the base of meter M-101 (see figure 5-1) until the pointer does rest over zero at the left hand side of the dial.

b. ELECTRICAL.—After the Multimeter has been connected to power and turned on and allowed to warm up, set function switch S-101 at —D.C.V. Ob-

serve the indication on meter M-101 with no signal connected to test leads W-101 and W-103. If it does not indicate zero, set ZERO ADJUST control, R-156, for a zero indication. Recheck the zero indication when you change function switch S-101 to +D.C.V. If it does not show zero for both of these settings of the function switch without changing the ZERO ADJUST control, the zero set screwdriver control, R-151, inside the instrument case needs to be adjusted; see paragraph 7-10 for the procedure. Set function switch S-101 at OHMS and short test leads W-102 and W-103 together. The meter should again read zero without any change in the settings of the ZERO ADJUST control, R-156.

c. CONTACT POTENTIAL ADJUST.—After the bridge circuit has been balanced with the ZERO ADJUST control, R-156 (paragraph *b* above), set function switch S-101 at A.C. Observe the indication on meter M-101 with no signal connected to test leads W-102 and W-103, or to diode probe W-104. If the meter does not indicate zero, set screwdriver control R-122, CONTACT POTENTIAL ADJUST, to obtain a zero indication. Recheck the zero indication when you change function switch S-101 to R.F. There should not be any difference of setting of control R-122 between the A.C. and R.F. positions of function switch S-101.

2. REPLACEMENT OF FUSES.

There are two cartridge type fuses in fuseholders in the upper right hand corner of the front panel of Multimeter ME-25B/U. Each fuse is in series with one side of the power input line. Failure of either of these fuses is indicated when you turn on power switch S-104 and pilot lamp I-101 fails to light; after a short warm up period, the meter pointer also fails to deflect and then comes to rest, as is normal for trouble-free conditions. To remove a fuse, unscrew the cap of the fuseholder; the fuse will come out with the cap. Either fuse, F-101 or F-102, may be burned out, and you will have to take each one out of its fuseholder to determine which is open. Replace the defective fuse with either of the two spares, F-103 or F-104, and try to operate the instrument. If a second fuse fails, there is definitely an overload trouble in the circuits of the instrument, and it should be corrected before the instrument is used again.

CAUTION

Do not use a fuse for replacement which has a rating higher than 1 ampere, or you may cause damage to the instrument.

3. REPLACEMENT OF PILOT LAMP.

Pilot lamp I-101 indicates when Multimeter ME-25B/U has power applied to its electronic circuits. Normally, when the lamp does not light, it indicates fuse failure (see paragraph 2 above). But if the pointer of meter M-101 is deflected during the warm up period when you have function switch S-101 set for voltage or resistance circuits, the pilot lamp is burned out and should be replaced. Unscrew the red faceted jewel cover over the bulb. Press in on the end of lamp I-101 and turn it about a quarter of a turn counter-clockwise; it has a bayonet base and will come out of the socket easily. Replace it with an exact equivalent.

4. REPLACEMENT OF BATTERY.

Battery BT-101 furnishes the power for resistance measurements. When it has worn out, you will not be able to obtain full scale deflection on meter M-101 with function switch S-101 set at OHMS and with test leads W-102 and W-103 separated. The OHMS ADJUST control, R-126, will correct for this condition during the normal period of service for battery BT-101. When you can no longer set the pointer for full scale deflection with the aid of control R-126, replace the battery with a fresh one. Battery BT-101 is located inside the case of Multimeter ME-25B/U, as shown in figure 7-3. To obtain access to the battery, remove the four large binder head screws through the corners of the front panel, and pull the front panel out of the case. Loosen the screw which holds battery contact E-118 to chassis H-101, and move contact E-118 to one side. Lift the old battery out of the trough in H-101 and replace it with a new one. Note the polarity of the new battery; its positive post at the top will contact E-118 when the installation is complete, and the negative case bottom will press against spring contact E-117 at the other end of the holder. Turn E-118 back into position again and hold the lead and terminal in position while you tighten the mounting screw. Be careful when you return the instrument to its case that you make gasket O-101 fit without any binding, and that you place the top of the panel at the top of the case. Guard handle A-104 and meter M-101 are at the top of the front panel, and the handle is on the top of the case.

SECTION 6
PREVENTIVE MAINTENANCE

1. DEFINITION OF PREVENTIVE MAINTENANCE.

Preventive maintenance is work performed on the equipment, usually when the equipment is not in use, to keep it in such good working order that breakdowns and needless interruptions in service will be kept to a minimum. Preventive maintenance differs from trouble shooting and repair since its object is to prevent certain troubles before they occur. The importance of preventive maintenance cannot be overemphasized. Therefore, it is important that the equipment be maintained properly.

2. PREVENTIVE MAINTENANCE PROCEDURE.

Preventive maintenance on Multimeter ME-25B/U consists of periodically checking in the following manner to determine that there is, or is not, a fault which is developing in the instrument which can be remedied before it causes repair to be necessary.

FEEL the knobs, cover clamps, fuse and lamp covers, meter, and guard handle to check for looseness or other evidence of deterioration.

INSPECT the surface appearance of the watertight gasket around the edge of the front panel of Multimeter ME-25B/U, and of the resistors, battery, and capacitors inside the case for evidence of deterioration, dirt accumulation, overheating, or other trouble.

TIGHTEN any loose fittings on the case, on the front panel, or within the case of the multimeter.

CLEAN away all dirt accumulations, corrosion, or other evidence of chemical action. Replace Moisture and Fungus protection whenever it is necessary.

ADJUST any looseness noted in the instrument by tightening all loose nuts and screws and any other parts which have become loose during the use of the instrument. Reset zero if it does not indicate properly with no voltage applied to the measuring circuits of the instrument. See paragraph 5-1 for the correct procedure.

No lubrication is required on Multimeter ME-25B/U.

3. ROUTINE MAINTENANCE CHECK CHARTS.

The check charts which follow this paragraph show the operator how to maintain the equipment so that trouble shooting and repair will be reduced to a minimum. They indicate what to check, how to check, and the precautions which you should take before, during, and after checking the equipment. The check charts are self-explanatory.

NOTE

Gasoline will not be used as a cleaning fluid for any purpose.

NOTE

The attention of maintenance personnel is invited to the requirements of Chapter 67 of the *Bureau of Ships Manual* of the latest issue.

TABLE 6-1. ROUTINE MAINTENANCE CHECK CHART

WHAT TO CHECK	WHEN TO CHECK	HOW TO CHECK	PRECAUTIONS
Front Panel	Weekly	Inspect the outside of the front panel. Check the mounting screws, switches, control knobs, fuse and pilot lamp covers, spare fuses, meter dial cover, and test and power leads.	
		Clean with a dry cloth.	Do not use gasoline or carbon tetrachloride as a cleaning fluid.
		Use dry compressed air to blow out dust and dirt which have accumulated.	Make sure air is free of oil vapor.
		Tighten loose screws and knobs as necessary.	
Accessories	Weekly	Inspect the high voltage probe extension, E-109, and the alligator clips, E-106, E-107, and E-108.	
		Clean with a dry cloth. Clean any evidence of corrosion with crocus cloth.	
		Use dry compressed air to blow out dust and dirt which have accumulated.	Make sure air is free of oil vapor.
Battery and Battery Trough	Weekly	Inspect the battery and the battery trough for any dirt or corrosion, or any swelling of the battery case.	
		Clean with a dry cloth. Clean any corrosion with a crocus cloth.	
		Replace the battery if it shows any swelling or corrosion.	Note the battery polarity.
Resistors	Monthly	Inspect the resistors for dirty surfaces, corrosion on leads, or discoloration showing overheating.	Do not move resistors with axial leads. The leads may break, and such defects are not repairable.
		Clean with a dry cloth. Use dry compressed air to blow out any accumulated dirt and dust.	Make sure air is free of oil vapor.
		Check the security of all mountings.	
Capacitors	Monthly	Inspect all the capacitors for signs of discoloration, leaks, bulges, dirt, corrosion, loose mountings and connections.	Do not move capacitors which are terminal mounted. The leads may break, and such defects are not repairable.
		Clean with a dry cloth. Use dry compressed air to blow out any accumulated dirt and dust.	Make sure air is free of oil vapor.

WHAT TO CHECK	WHEN TO CHECK	HOW TO CHECK	PRECAUTIONS
Switches	Monthly	Inspect for dirt accumulation on the surface of insulators and in contacts.	
		Clean with a dry cloth. If there is any dust or dirt inside switch contacts, flow a small amount of Dry Cleaning Solvent 140-F (SNSN G51-S-4718-10 for 5 gal. drum) inside the contact.	Do not use gasoline or carbon tetrachloride as a cleaning fluid.
		Use dry compressed air to blow out the cleaning fluid.	Make sure air is free of oil vapor.
Tubes	Monthly	Inspect the tube pins and sockets for dust and dirt or corrosion. Check each tube in a tube tester.	
		Replace any weak tubes.	Multimeter must be recalibrated when V-103 is replaced.
		Clean with a dry cloth. Clean any corrosion with a crocus cloth. If there is any dust or dirt in tube socket contacts, flow a small amount of dry cleaning solvent 140-F (SNSN G51-S-4718-10 for 5 gal. drum) inside the contact.	Do not use gasoline as a cleaning fluid.
		Use dry compressed air to blow out the cleaning fluid.	Make sure air is free of oil vapor.
Calibration	Monthly	Check the indications of Multimeter ME-25B/U against the indications of another piece of test equipment known to be in good working order, or against standard values of voltage and resistance.	
		Recalibrate as necessary. Note effects of parts which are wearing out, such as the battery, tubes, etc.	

Note: In the event of use in tropical areas where fungus growth may be encountered, frequent inspection of Multimeter ME-25B/U should be observed, especially if the instrument has been stored. Components showing any signs of fungus growth should be cleaned and then coated with a fungus resistant lacquer. Do not cover contacts of the rotary switches with lacquer.

FAILURE REPORTS

A FAILURE REPORT must be filled out for the failure of any part of the equipment whether caused by defective or worn parts, improper operation, or external influences. It should be made on Failure Report, form NAVGEN 1025, which has been designed to simplify this requirement. The card must be filled out and forwarded to BUSHIPS. Full instructions are to be found on each card.

Use great care in filling the card out to make certain it carries adequate information. For example under "Circuit Symbol" use the proper circuit identification taken from the schematic drawings, such as T-803, in the case of a transformer, or R-207, for a resistor. Do not substitute brevity for clarity. Use the back of the card to completely describe the cause of failure and attach an extra piece of paper if necessary.

The purpose of this report is to inform BUSHIPS of the cause and rate of failures. The information is used by the Bureau in the design of future equipment and in the maintenance of adequate supplies to keep the present equipment going. The cards you send in, together with those from hundreds of other ships, furnish a store of information permitting the Bureau to keep in touch with the performance of the equipment of your ship and all other ships of the Navy.

This report is not a requisition. You must request the replacement of parts through your Officer-in-Charge in the usual manner.

Make certain you have a supply of Failure Report cards and envelopes on board. They may be obtained from the nearest District Printing and Publication Office.

Figure 7-1. Failure Reports.

SECTION 7
CORRECTIVE MAINTENANCE

1. THEORY OF LOCALIZATION.

Each type of circuit which you can set up in Multimeter ME-25B/U requires a special group of component parts. For this reason, localization and trouble shooting are simplified for this unit. The trouble shooting chart shown in table 7-1 should be used as a guide to help locate any source of trouble when it develops. It is not necessarily an all-inclusive list of the parts which may be involved in any trouble, but it does indicate the probable location of a fault in accordance with the behavior which the instrument exhibits. When the trouble occurs on only one range of the instrument, use the partial schematic diagram in Section 2 which shows the component parts for each type of circuit. From the partial schematic, determine the part or parts which are most likely to be at fault. The trouble may be in the part itself, or in the wiring to or from the part, or it may be mechanical connections or calibration setting. Examine the part and its connections, etc., carefully to identify the nature of the trouble before you begin unnecessary disassembly and repair on the instrument.

CAUTION

Be careful to prevent overheating the SRIR wire insulation when you solder or unsolder any connections of insulated leads. Grasp the wire lead with long nose pliers between the insulation and the point where you apply the heat; this will tend to dissipate the heat before it damages the insulation.

2. REMOVAL OF CASE.

All the component parts which are included inside the case of Multimeter ME-25B/U are attached to the back of the front panel. To reach them, remove the four large binder head screws which are through the four corners of the front panel, and pull the front panel straight out of the case. Note that the rubber gasket which seals the instrument when the cover is clamped in position is attached on the outer edge of the front panel. Its lip extends under the inside face of the case. When you return the instrument to the case, be careful to prevent damage to this gasket, O-101, and to see that it slips in place under the case edge all the way around.

3. BATTERY REPLACEMENT.

Battery BT-101 is a JAN type BA-30 dry cell which is located inside the case of Multimeter ME-25B/U as shown in figure 7-2. When the case of the battery is discolored, or when it shows any other evidence of deterioration, replace it with a fresh cell. Figure 7-5 shows how the battery is held in the battery trough, which is part of chassis H-101. Spring contact E-117 presses against the base of the battery, which is its negative terminal. This contact is insulated from the chassis. Contact E-118 acts as the grounded connection for positive battery polarity, and is also a clamp which holds the battery in its trough. To remove the battery, loosen the screw which holds contact E-118 to chassis H-101, and turn contact E-118 until it clears the top of the battery case. Lift the old battery out of the trough. When you place the new battery in the trough, be sure to observe polarity: insert the bottom first until it presses against spring contact E-117. Then turn contact E-118 into position so its extruded contact point connects the small positive post in the center of the top of the battery. When E-118 presses against the post of the battery, it will also be in position to clamp the battery in its trough. Hold the terminal lug for the two black leads, which is also fastened in position with the screw through E-118 and H-101, while you tighten the screw again.

4. REPLACEMENT OF ROTARY SWITCHES S-101 AND S-102.

If at any time you find it necessary to replace either of the rotary switches, S-101 or S-102, use the following procedure.

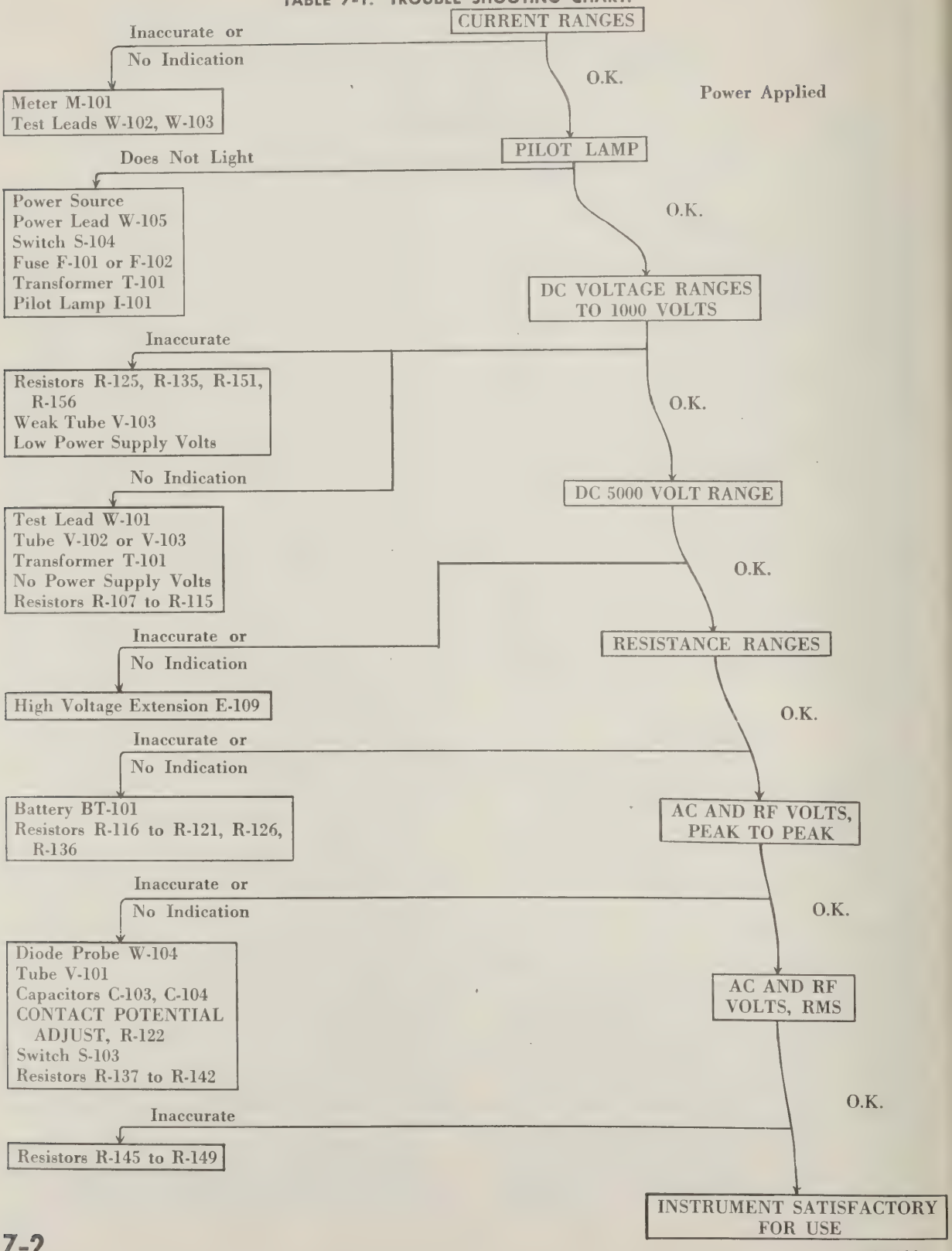
a. Obtain the replacement part before you disconnect any leads from the old switch.

b. With the aid of the old switch, and with the view which shows how it is wired, figure 7-6 or 7-7, connect all the jumper wires which go between the different contacts on the same switch.

c. Disconnect one lead at a time from the original switch and transfer it to the replacement switch, being careful to solder it to the same contact on the new switch.

d. Turn the knob of the old switch so it is in its full counter-clockwise position. Loosen the two set screws; one is at the top of the knob and the other is on the right hand side. Pull off the knob.

TABLE 7-1. TROUBLE SHOOTING CHART.



e. Use a ½-inch hex nut driver to loosen the nut on the shaft of the old switch. Remove the nut and the lockwasher under it.

f. Remove the old switch from the back of the panel.

g. Place the new switch in position through the hole in the insulator panel through which you removed the old switch. Be sure that you do not press down on any leads with the switch as you move it into position.

h. Rotate the new switch until its locking device fits into the hole provided in the insulator, E-110.

i. Fasten the switch to the insulator with a lockwasher and a ½-inch hex nut. Use the nut driver to tighten the switch on the insulator.

j. Rotate the shaft of the switch so it is in its full counter-clockwise position.

k. Place the knob over the switch shaft and turn it so it points to the full counter-clockwise position mark on the front panel. Tighten the two set screws to hold the knob in this position.

l. Test the knob for tightness by turning the switch through all its positions and watching for any slippage of the knob on its shaft.

5. REPLACEMENT OF METER M-101.

a. Remove the four nuts and lockwashers which hold terminal board TB-102 to the screws through chasses H-101 and H-102. Fold the terminal board out of the way over the top of the front panel.

b. Remove the two large binder head screws which hold guard bar A-104 to the front panel and remove the guard bar.

c. Use a ¼-inch nut driver to remove the four nuts which fasten the mounting bolts at the corners of meter M-101 to the panel. Remove the four lockwashers which are under the nuts.

d. Slip meter M-101 out through the front panel. Its leads are long enough to permit removal of the meter from the panel before the leads are disconnected from it.

e. Use a ⅜-inch nut driver to take off the nuts which hold the terminals to the studs on the rear of the meter.

f. Place the terminals on the studs at the rear of the new meter. Connect the red lead to the stud marked +, and the white lead to the meter negative (the stud for this is not marked).

g. Assemble the meter to the panel by reversing the disassembly procedure above.

6. REPAIR OF DIODE PROBE W-104.

Figure 7-8 is an exploded view of diode probe W-104. It is the large black lead and rectifier housing which is stored in the left hand section of lead compartment A-105. The lead end of the diode probe passes through a hole in the rear of the lead compartment and is soldered to connection points on terminal board TB-104. There is a locking bushing, O-105, which fastens the lead and supports it at the point where it passes through the lead compartment wall. The probe end of this lead has a closed sleeve which encloses the parts shown in figure 7-8. If it is necessary to obtain access to any of the parts inside the sleeve, proceed as follows:

a. With a $\frac{3}{16}$-inch nut driver, remove sleeve nut H-106.

b. Remove the three small screws which hold aluminum shell A-109 to the bakelite front bushing, A-108.

c. Slide bakelite piece A-108 forward, off the end of probe E-112.

d. Slide A-109 and A-110 back along the lead wire to expose all the parts inside the shell.

e. To reassemble, reverse the above steps, being careful to seat fastener O-102 in the slot on the inner face of A-110.

CAUTION

Be sure to remove sleeve nut H-106 before you place any strain on the leads of capacitor C-103, or you will break the capacitor leads. Such a defect cannot be repaired, and you will have to replace the capacitor.

7. REPLACEMENT OF TUBES.

a. REPLACEMENT OF TUBE V-101.—Tube V-101 is a type 6AL5 which is located inside the diode probe head, W-104. The location is shown in figure 7-8. Paragraph 6 above indicates how you can obtain access to the parts which are inside this housing. If you have to replace the tube, remove the housing over the parts in the probe head, and then remove tube V-101 from socket XV-101. Place the new type 6AL5 tube in the socket and fit the tip of the tube into the center hole of terminal board TB-105 (see figure 7-15). Then put the housing back together again, observing the procedure and caution in paragraph 6.

b. REPLACEMENT OF TUBE V-102.—Tube V-102 is a type 6X4 full wave rectifier in the power supply. It is located inside the case of Multimeter ME-25B/U as shown in figure 7-2. Remove the tube shield, E-111, from socket XV-102, and you will have access to the tube. After you have replaced it with a new tube, put shield E-111 back in place on socket XV-102.

c. REPLACEMENT OF TUBE V-103.—Tube V-103 is a type 6SN7GT dual triode. It is used as the bridge tube for all voltage and resistance measurements. It is located inside the case of Multimeter ME-25B/U as shown in figure 7-2. There is no tube shield over this tube, and you can remove and replace

it without moving any other parts. The instrument will have to be recalibrated whenever you replace tube V-103 because the change of tube characteristics will affect meter indications for voltage and resistance readings. See paragraph 9 below for calibration instructions.

8. REPAIR OF HIGH VOLTAGE EXTENSION E-109.

High voltage extension E-109 is screwed on over the end of test lead W-101 to multiply the DC voltage ranges by 5. It is intended to be used with range switch S-102 set at 1000 V MA 5000 V.D.C. when the operator wants to have a 5000 volt DC range. But it will multiply any other DC voltage range by 5 when it is used with W-101. The red plastic handle, A-111, contains multiplier resistor R-101, connector H-107 which screws on the shoulder of the test probe tip, and key washer H-105. The parts are fastened inside the handle with key washer H-105. To open the assembly as shown in figure 7-9, exploded view, screw the extension on the end of any of the test leads, W-101, W-102, or W-103, and pull the parts straight out of the handle. Key washer H-105 scrapes on the inside wall of the housing, but will give and allow the parts to come out when you pull hard enough. If the key washer is damaged when you pull the assembly apart, be sure to flatten it out and straighten the corners before you reassemble the parts in the housing. Replace the key washer when you can no longer flatten it.

9. CALIBRATION PROCEDURE.

Whenever you replace tube V-103, or at any other time when Multimeter ME-25B/U shows incorrect values for voltage or resistance readings on any range, recalibration may be necessary. Proceed as follows.

a. DC VOLTAGE CALIBRATION.

(1) With power off, set the pointer of the meter at zero with the small screw through the face of meter M-101.

(2) Turn the power ON and allow the instrument time to warm up and stabilize its meter indications. Set the ZERO ADJUST control for a zero indication on meter M-101.

(3) Set function switch S-101 at —D.C.V. and range switch S-102 at the proper position for the value of voltage which will be used for DC calibration. Any known, or steady and measured, value of DC voltage within the range of the instrument may be used for this. It is wise to measure the calibrating voltage with a known good meter at the same time that you are calibrating Multimeter ME-25B/U. Connect the second voltmeter in parallel with Multimeter ME-25B/U.

(4) Connect Multimeter ME-25B/U to the source of known voltage. Connect the negative polarity with test lead W-101, and the positive polarity with test lead W-103.

(5) Check the indication on meter M-101. If it reads correctly, proceed to step (8) below.

(6) If the meter does not read the correct value of applied voltage, adjust resistor R-125 to provide the correct indication. This screwdriver adjustment is located on terminal board TB-101. See figure 7-10 for the location.

(7) After you have adjusted R-125 for the proper indication on meter M-101, disconnect the leads from the source of voltage.

(8) Set switch S-101 at +D.C.V.

(9) Connect test lead W-101 to the positive source of calibrating voltage, and test lead W-103 to the negative source.

(10) Recheck to see that meter M-101 indicates the proper value for positive polarity indications as well as for negative polarity readings.

(11) Disconnect the DC calibrating voltage source. If another value of DC calibrating voltage is available, recheck the accuracy of indications on both DC polarities with the instrument for this additional source. If necessary, set resistor R-125 at a compromise position which will allow all indications to be within specified tolerance.

b. AC VOLTAGE CALIBRATION.

(1) Set function switch S-101 at A.C. Check the meter indication with no voltage applied to the test leads. If it does not indicate zero, use a screwdriver to set CONTACT POTENTIAL ADJUST resistor, R-122, for a zero indication on the meter.

(2) See that diode probe W-104 is properly seated in lead compartment A-105, so that its tip contacts jack J-101. Figure 4-2 is a cutaway view which shows how these parts fit together.

(3) Set range switch S-102 at 1 V MA Rxl. Obtain a steady measured AC voltage source which has a peak-to-peak value of 1 volt or less.

(4) Connect test leads W-102 and W-103 across the source of calibrating voltage. Press the switch marked PRESS FOR PEAK TO PEAK, S-103, and read the indication on meter M-101.

(5) If necessary, correct the meter indication by adjusting resistor R-138. See figure 7-10 for the location of resistor R-138 on terminal board TB-101. Release switch S-103, and disconnect the test leads from the source of voltage.

(6) Obtain a steady measured voltage source which has an RMS value of 1 volt or less. Connect test leads W-102 and W-103 across this source of voltage.

(7) Read the indication of the RMS value on meter M-101. If necessary, adjust resistor R-145 for the proper indication. See figure 7-10 for the location of R-145 on terminal board TB-101. Disconnect the test leads from the source of voltage.

(8) Set range switch S-102 at 2.5 V MA Rx10. Obtain a source of steady measured voltage which has a peak-to-peak value of 2.5 volts or less. Connect test leads W-102 and W-103 across this source of calibrating voltage.

(9) Press switch S-103, PRESS FOR PEAK TO PEAK, and observe the peak-to-peak voltage indicated on meter M-101. If necessary, adjust resistor R-139 for the correct indication. Disconnect the test leads from the source of voltage.

(10) Obtain a source of steady measured voltage with an RMS value of 2.5 volts or less. Connect test leads W-102 and W-103 across this source of voltage.

(11) Read the RMS voltage indicated on meter M-101. If necessary, adjust resistor R-146 for the proper indication. See figure 7-10 for the location of R-145 on terminal board TB-101. Disconnect the test leads from the source of voltage.

(12) Set range switch S-102 at 10 V MA Rx100. Obtain a steady measured source of AC voltage with a peak-to-peak value of 10 volts or less. Connect test leads W-102 and W-103 across this source of voltage.

(13) Press switch S-103, PRESS FOR PEAK TO PEAK, and read the peak-to-peak voltage indicated on meter M-101. If necessary, adjust resistor R-140 for the proper indication. Figure 7-10 shows the location of resistor R-140 on terminal board TB-101. Disconnect the test leads from the source of voltage.

(14) Obtain a source of steady measured voltage with an RMS value of 10 volts or less. Connect the test leads, W-102 and W-103, across this source of voltage.

(15) Read the RMS indication on meter M-101. If necessary, adjust resistor R-147 for the proper indication. See figure 7-10 for the location of resistor R-147 on terminal board TB-101. Disconnect the test leads from the source of voltage.

(16) Set range switch S-102 at 25 V MA Rx1K. Obtain a steady measured source of voltage with a peak-to-peak value of 25 volts or less. Connect the test leads, W-102 and W-103, across this source of voltage.

(17) Press switch S-103, PRESS FOR PEAK TO PEAK, and read the peak-to-peak value indicated on meter M-101. If necessary, adjust resistor R-141 for the proper indication. This resistor is located on terminal board TB-101 as shown in figure 7-10. Resistor R-141 is also the calibrating resistor for the 100, 250, 500, and 1000 volt ranges of peak-to-peak AC voltage indications as well as for the 25 volt range. Test the setting of resistor R-141 by applying several voltages which will be measured on the higher AC ranges, and compromise the setting if necessary. Disconnect the test leads from the voltage source.

(18) Set range switch S-102 at 25 V MA Rx1K again. Obtain a steady measured source of voltage which has an RMS value of 25 volts or less. Connect test leads W-102 and W-103 across this source of voltage.

(19) Read the RMS value of the applied voltage on meter M-101. If necessary, adjust resistor R-148 for the correct indication. See figure 7-10 for the location of resistor R-148 on terminal board TB-101. Resistor R-148 is also the calibrating resistor for the 100, 250, 500, and 1000 volt ranges of RMS indications as well as for the 25 volt range. Test the setting of resistor R-148 by measuring several voltages which require the higher ranges. If necessary, compromise the setting for resistor R-148 to provide proper indications on all the ranges. Disconnect the test leads from the source of voltage.

10. ZERO SET CONTROL R-151.

Screwdriver control R-151 is located on terminal board TB-102, as shown in figure 7-12. With it, you will set the range of voltage for the parallel circuit at a level around ground potential. The parallel path consists of resistors R-154, R-155, and R-156, all in series with each other. Adjust resistor R-151 with the following procedure, using DC voltage indications on meter M-101.

a. With the power switch, S-104, set at OFF, use a small screwdriver on the zero setting screw at the bottom of the face of meter M-101 to make the meter read zero.

b. Set power switch S-104 at ON and allow enough time for the instrument to warm up and stabilize its indications.

c. Set function switch S-101 at —D.C.V.

d. Rotate the ZERO ADJUST control on the front panel, R-156, fully clockwise. Note that the meter pointer moves up-scale. Read and record the indicated voltage on meter M-101.

e. Set function switch S-101 at +D.C.V. Rotate the ZERO ADJUST control knob fully counter-clockwise. Note that the meter pointer moves up-scale again. Read and record the indicated voltage on meter M-101.

f. Compare the voltages which you have recorded for steps *d* and *e* above. If they are equal, the zero set control, R-151, is set correctly. If they are not equal, adjust R-151 for equal voltages in steps *d* and *e*. Note that any adjustment of R-151 will affect both readings. As you decrease one amount, the other will automatically increase.

g. Turn the ZERO ADJUST control, R-156, for a zero indication on meter M-101 after R-151 has been set correctly. Test the setting by turning function switch S-101 back and forth between +D.C.V. and —D.C.V. to see whether the same setting of ZERO ADJUST control R-156 will give a zero indication for each position of function switch S-101.

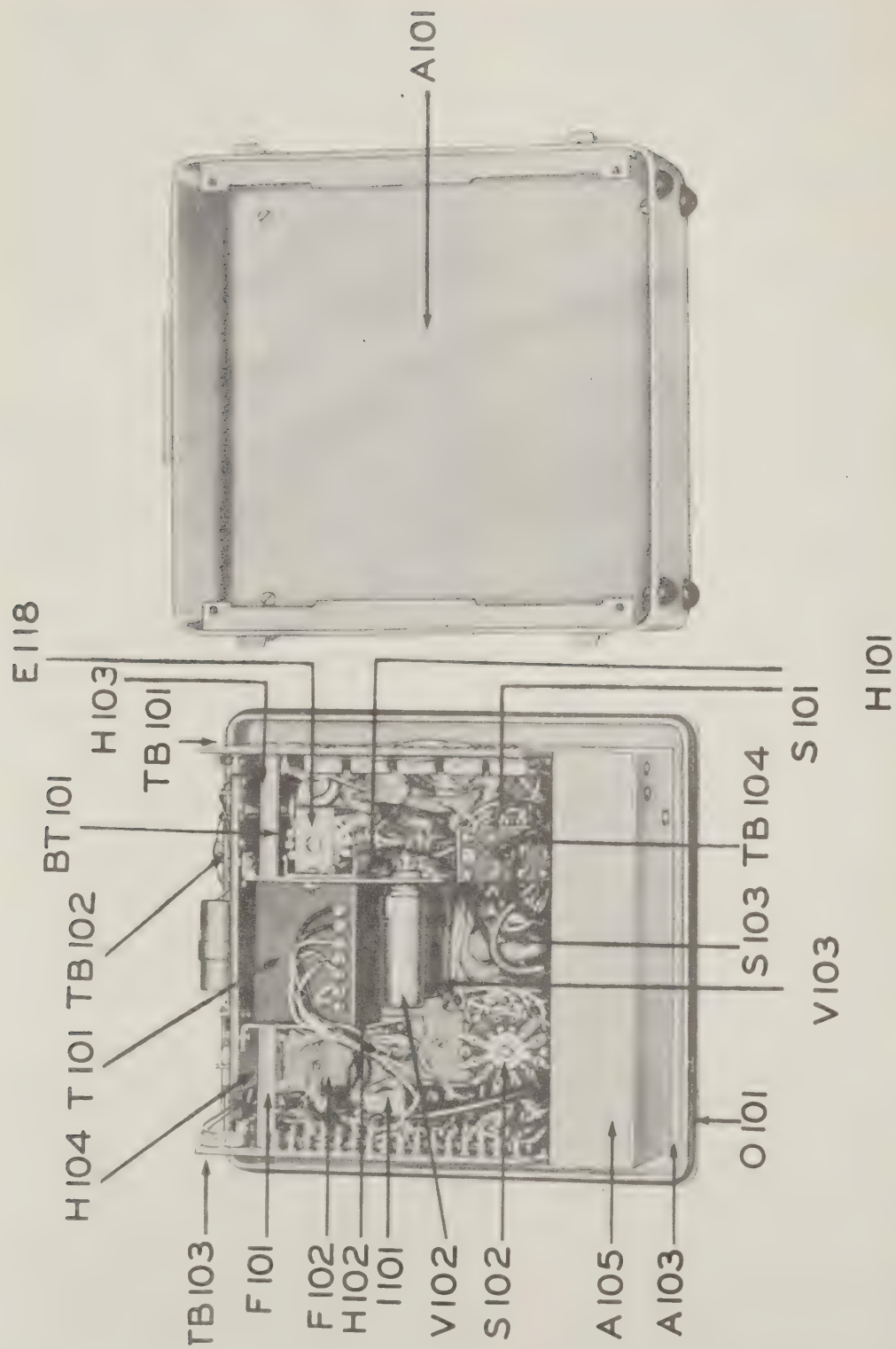


Figure 7-2. Rear View of Front Panel, Multimeter ME-25B/U.

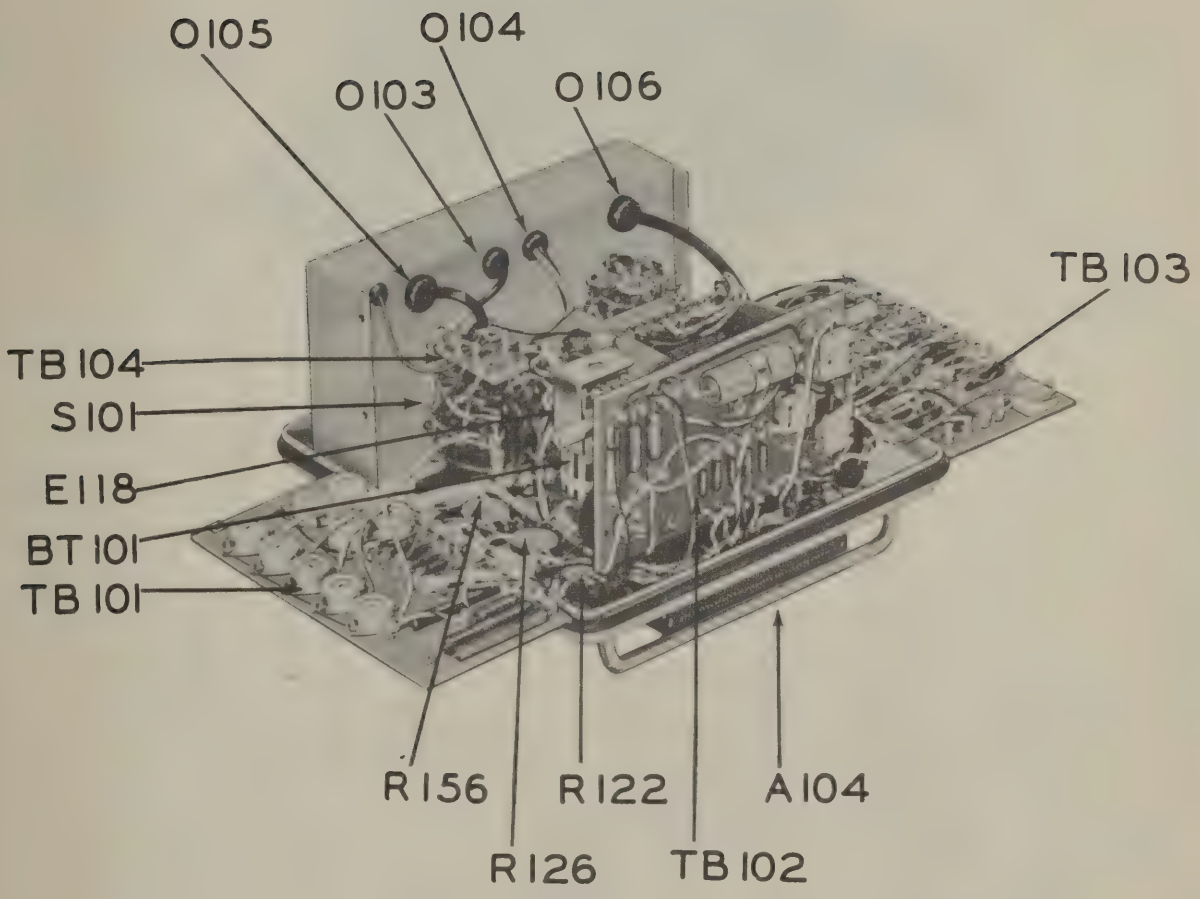


Figure 7-3. Left Oblique View of Rear of Front Panel.

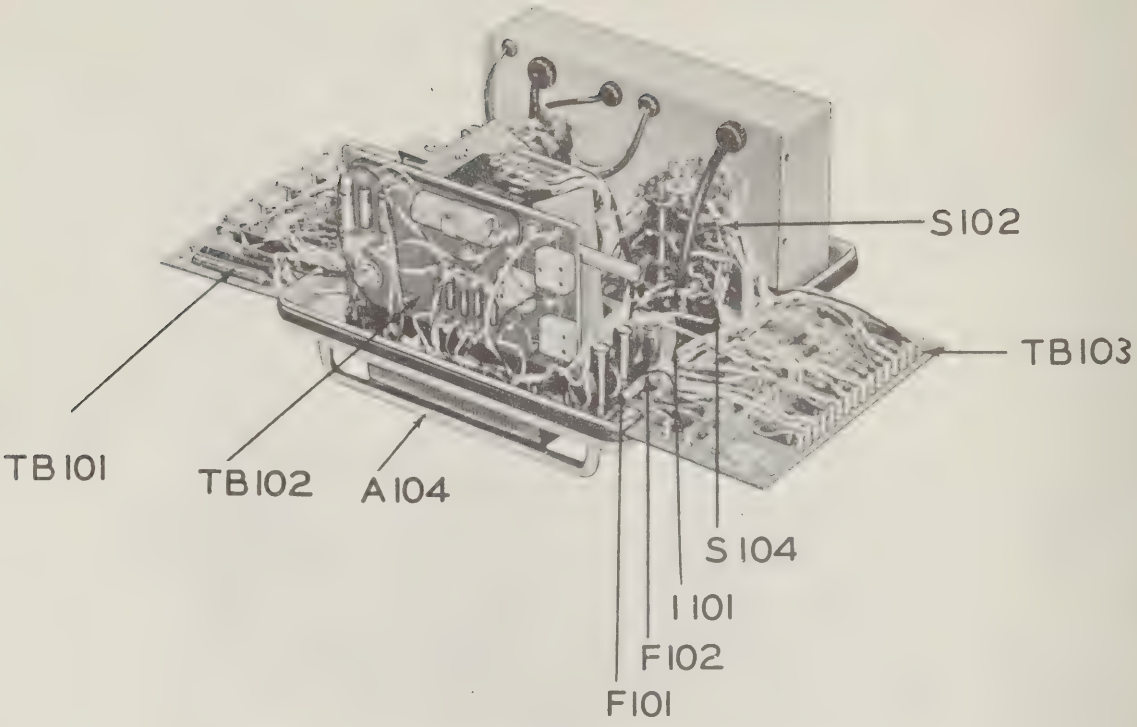


Figure 7-4. Right Oblique View of Rear of Front Panel.

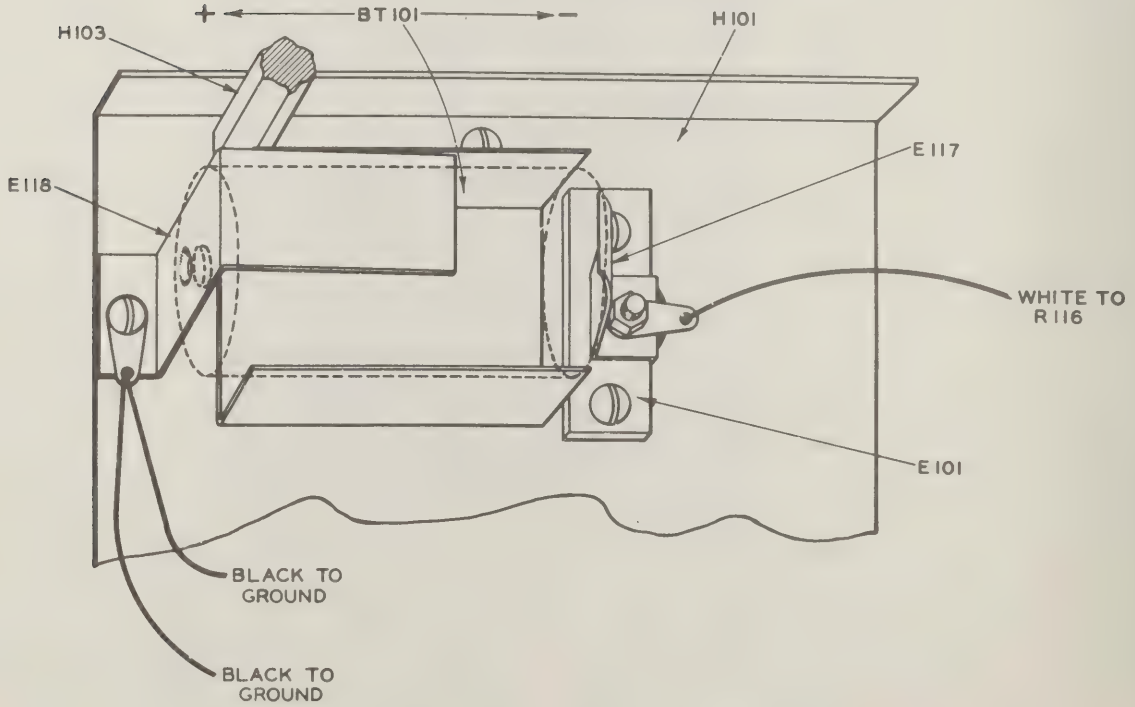


Figure 7-5. Battery Trough and Clamp.

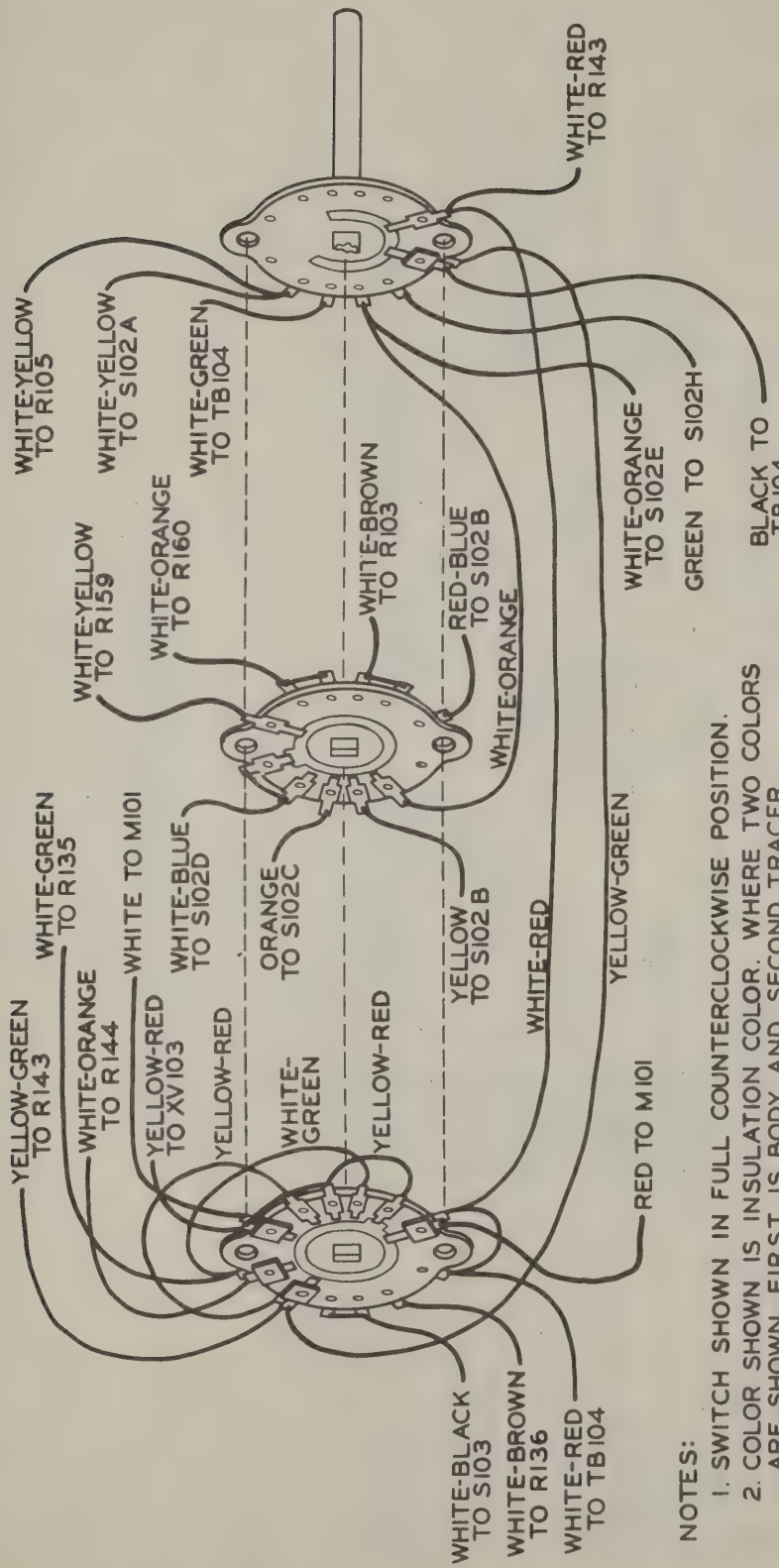
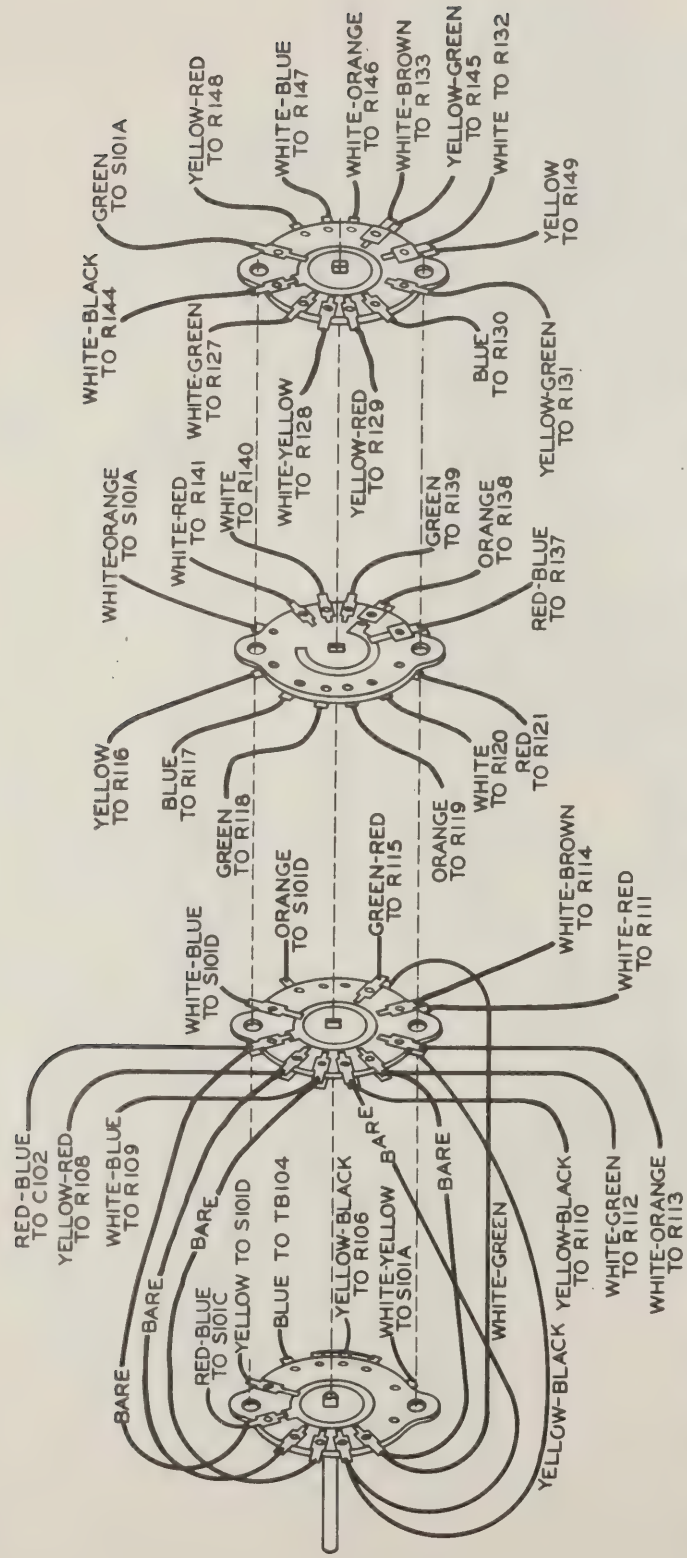


Figure 7-6. Wiring of Function Switch S-101.



NOTES:
1. SWITCH SHOWN IN FULL COUNTERCLOCKWISE POSITION.
2. COLOR SHOWN IS INSULATION COLOR. WHERE TWO COLORS ARE SHOWN FIRST IS BODY AND SECOND IS TRACER.

Figure 7-7. Wiring of Range Switch S-102.

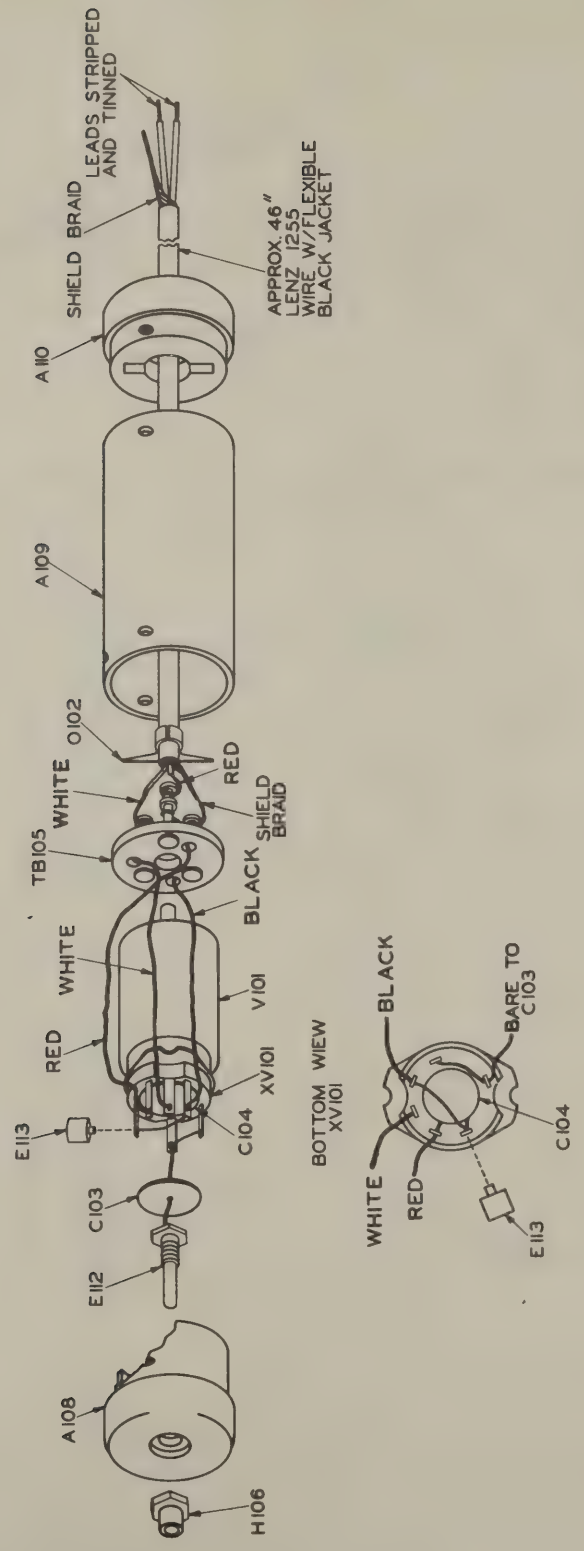


Figure 7-8. Exploded View of Diode Probe W-104.

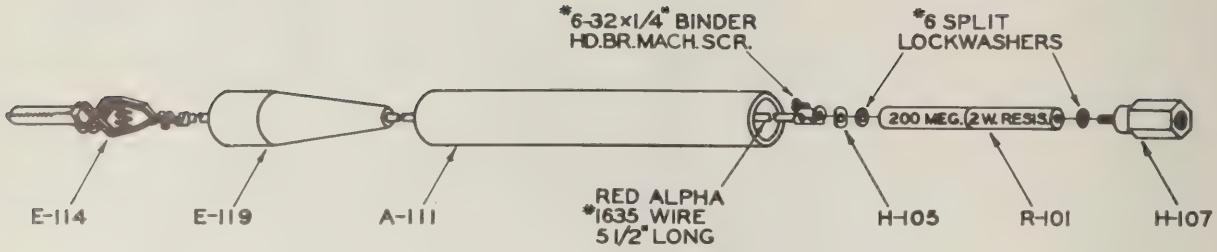


Figure 7-9. Exploded View of High Voltage DC Probe Extension E-109.

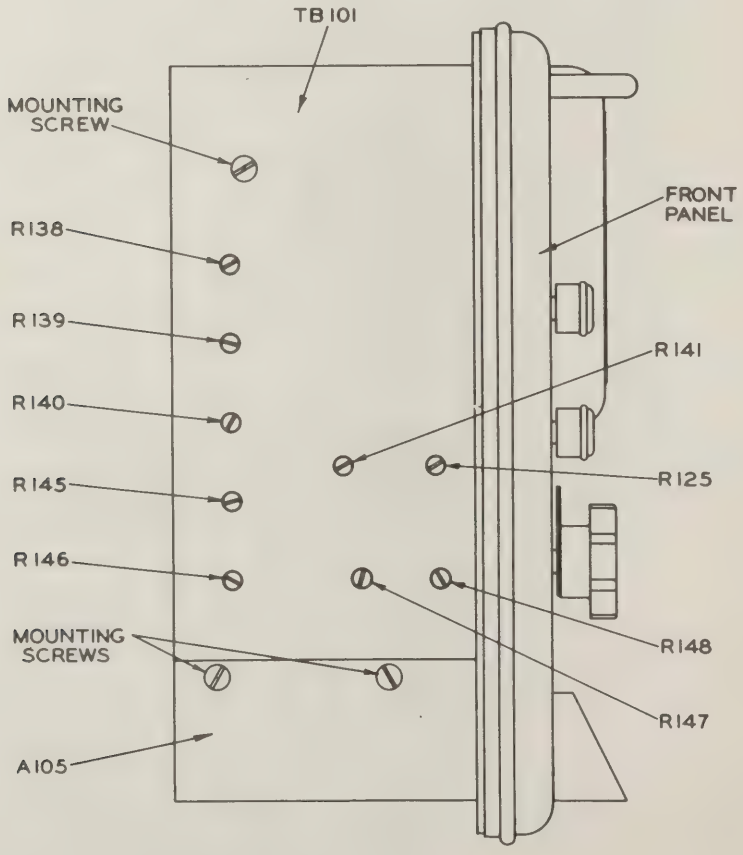
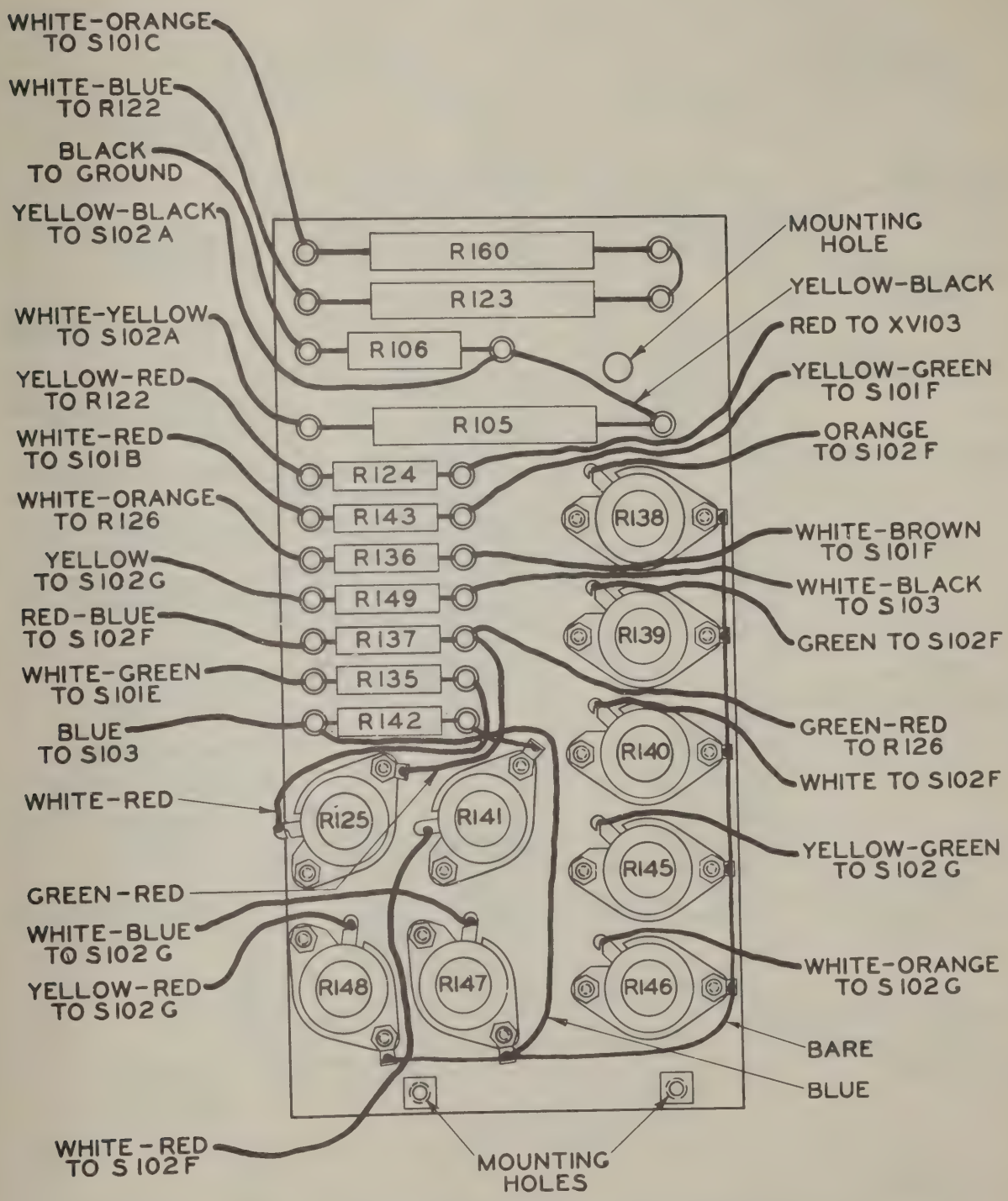
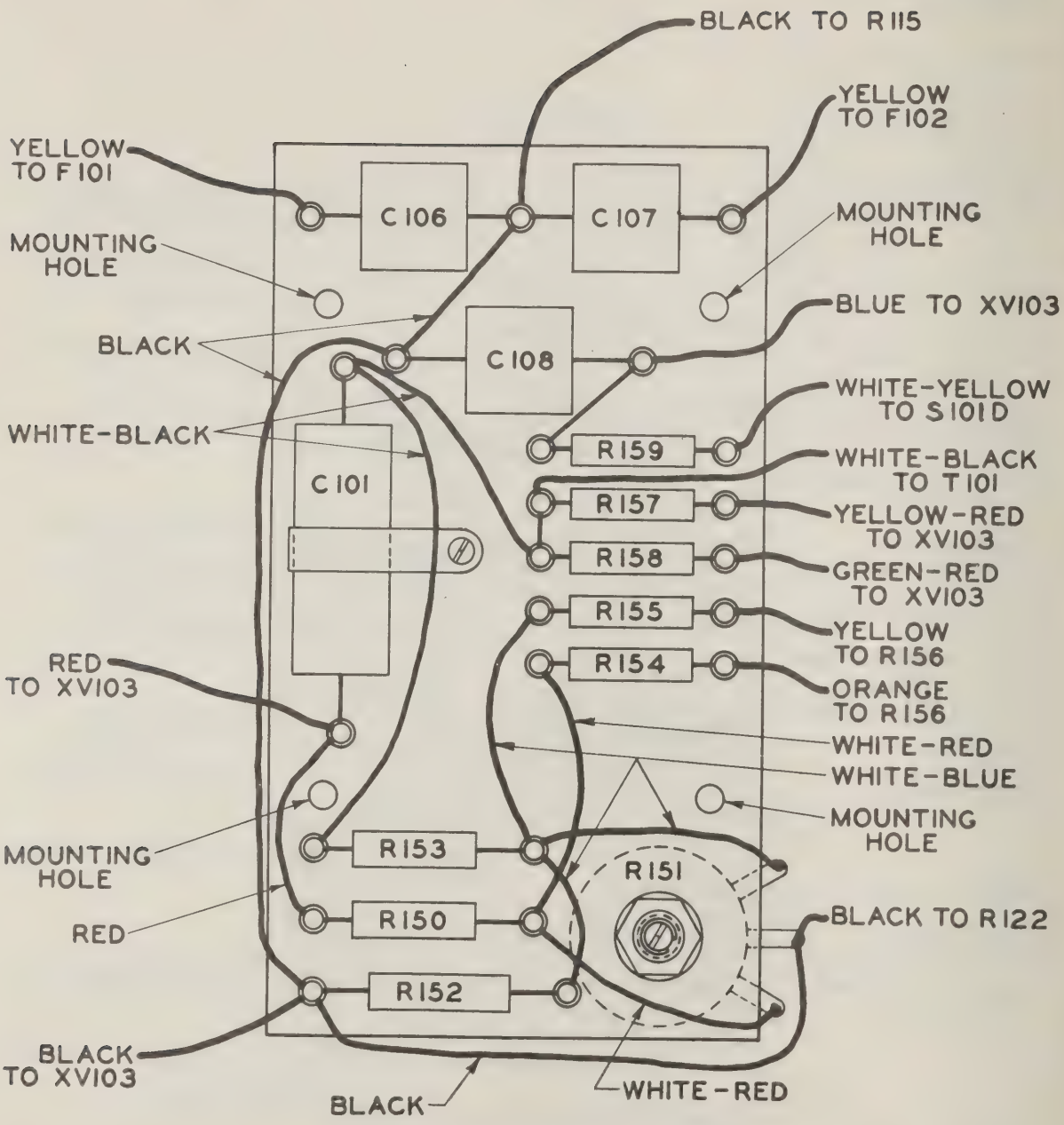


Figure 7-10. Location of Calibrating Adjustments on Terminal Board TB-101.



NOTE:
COLOR SHOWN IS INSULATION COLOR. WHERE TWO COLORS ARE SHOWN FIRST IS BODY AND SECOND TRACER.

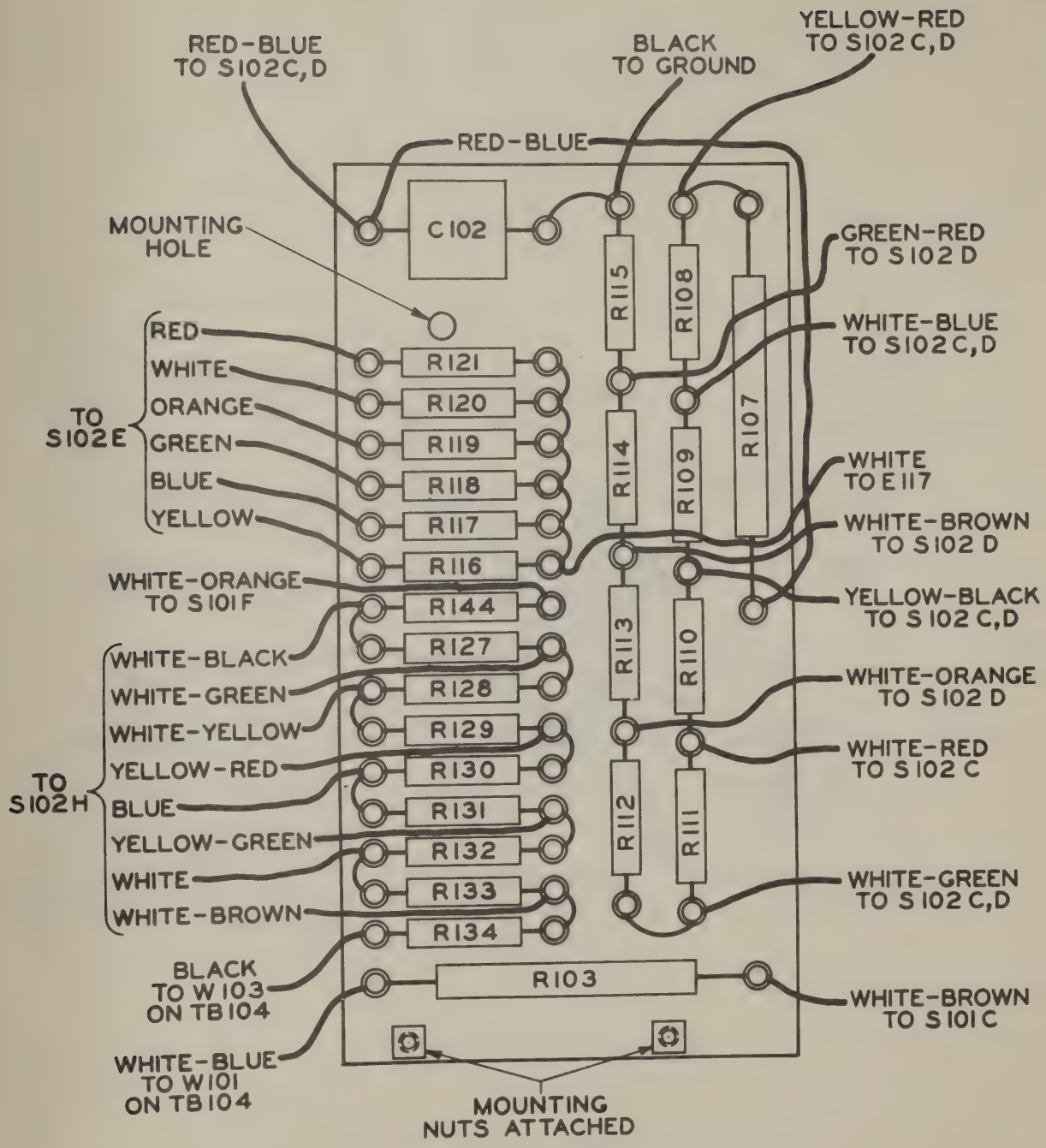
Figure 7-11. Location of Component Parts on Terminal Board TB-101.



NOTE:

COLOR SHOWN IS INSULATION COLOR.
WHERE TWO COLORS ARE SHOWN FIRST IS BODY AND SECOND TRACER.

Figure 7-12. Location of Component Parts on Terminal Board TB-102.



NOTE:
COLOR SHOWN IS INSULATION COLOR.
WHERE TWO COLORS ARE SHOWN FIRST IS BODY AND SECOND TRACER.

Figure 7-13. Location of Component Parts on Terminal Board TB-103.

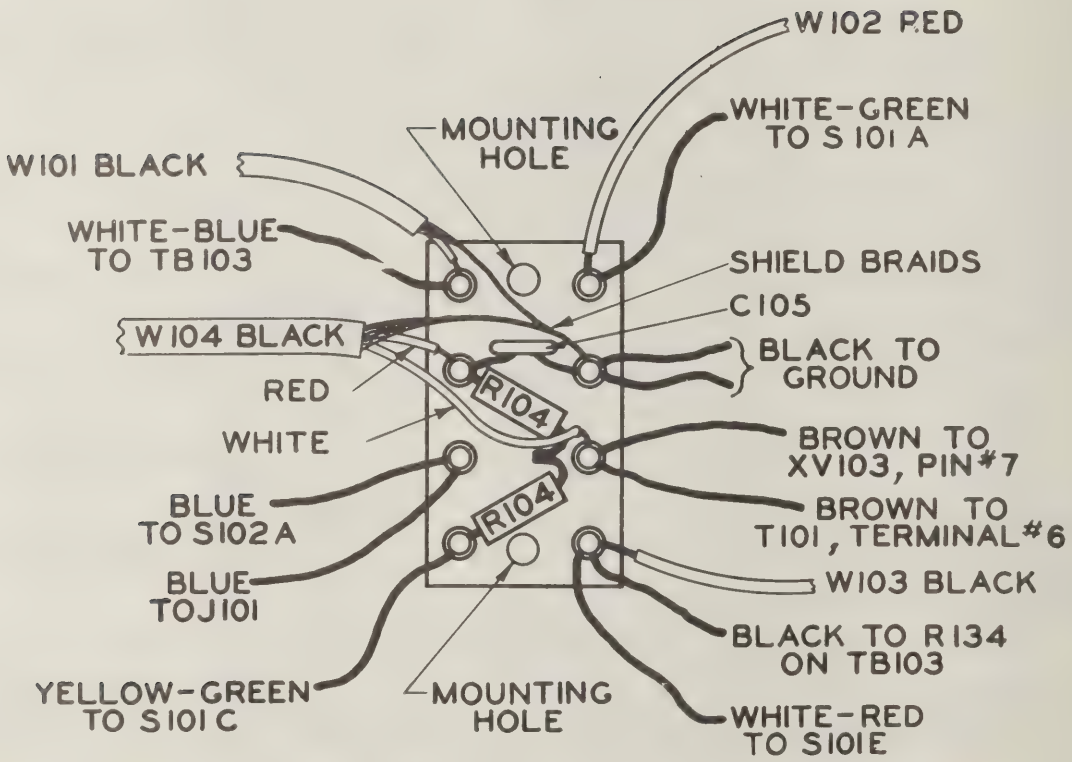


Figure 7-14. Location of Component Parts on Terminal Board TB-104.

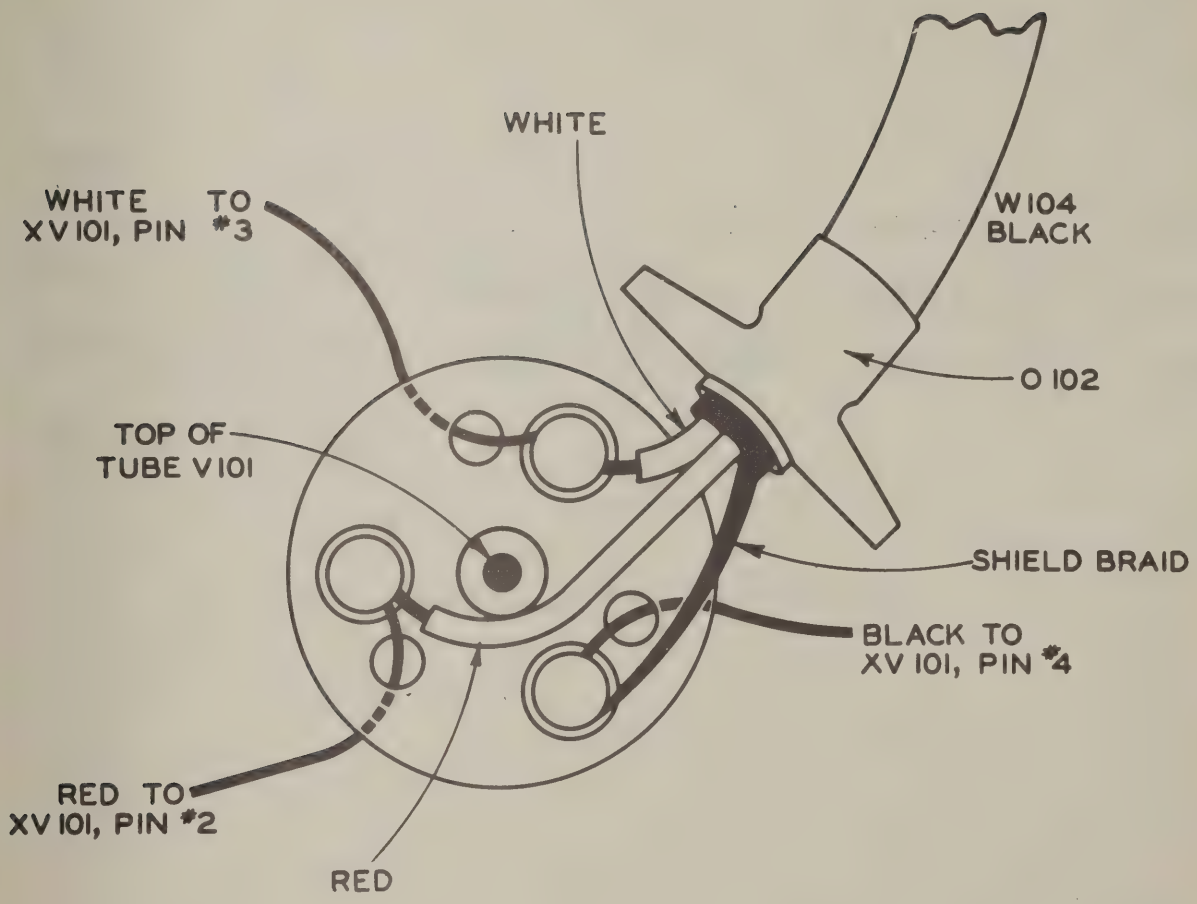


Figure 7-15. Wiring Connections on Terminal Board TB-105.

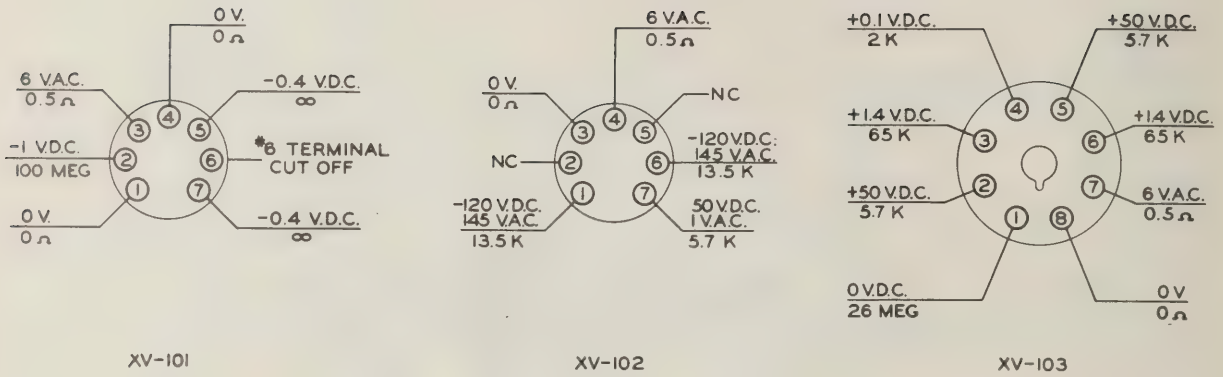


Figure 7-16. Tube Socket Voltage and Resistance Chart.

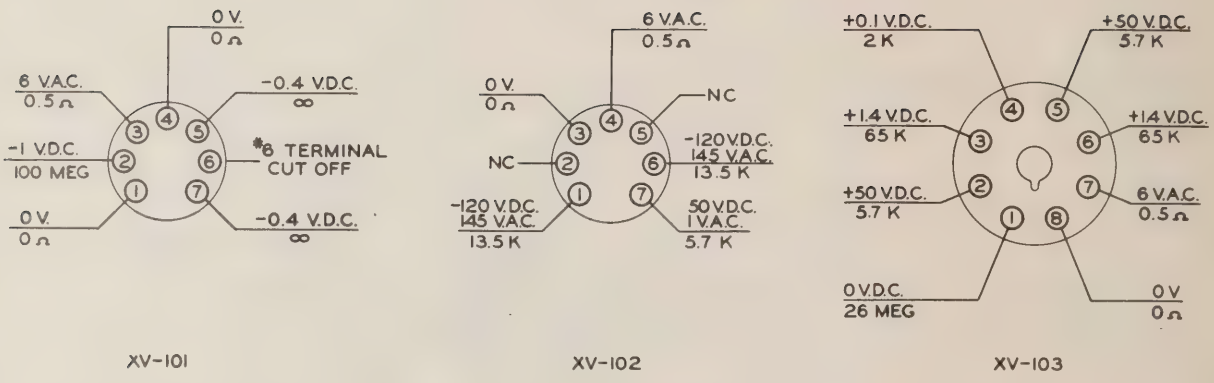


Figure 7-16. Tube Socket Voltage and Resistance Chart.

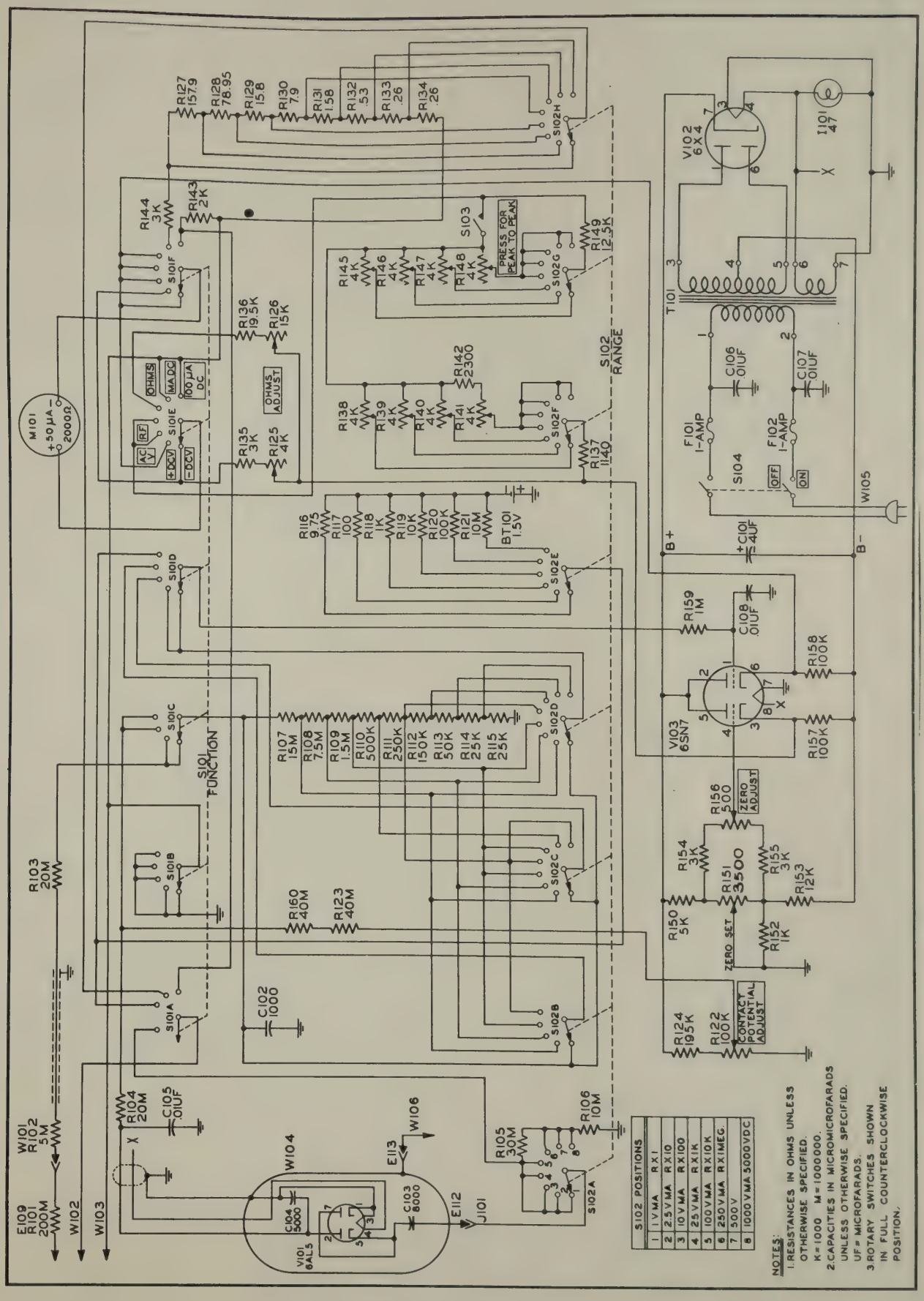


Figure 7-17. Overall Schematic Diagram, Multimeter ME-25B/U.

SECTION 8

PARTS LISTS

TABLE 8-1. PARTS LIST

SYMBOL DESIGNATION	STANDARD NAVY STOCK NO.	NAME OF PART AND DESCRIPTION	FUNCTION	MFGR. AND MFGR'S. DESIG.	SIMPSON DWG. AND PART NO.	ALL SYMBOL DESIG. INVOLVED	NO. OF TIMES IN UNIT
A-101	Low failure item–if required requisition from ESO referencing NavShips 900, 180A	CASE, METER: aluminum; smooth grey enamel finish; over-all dim. excluding handle, clamp latches, and rubber feet, 9½″ lg x 9½″ h x $3\frac{27}{64}$″ deep; 1 handle located on top; special watertight assembly	Houses instrument portion of Multimeter ME-25B/U		10-890176	A-101	1
A-102	N17-C-945002-651	COVER, MULTIMETER: aluminum; smooth grey finish; over-all dim. excluding clamps and foot, 9½″ lg x 9½″ h x $1\frac{31}{32}$″ deep; special watertight assembly	Covers front panel of Multimeter ME-25B/U		10-890177	A-102	1
A-103	Low failure item–if required requisition from ESO referencing NavShips 900, 180A	PANEL, MOUNTING: aluminum; smooth grey enamel finish; over-all dim. excluding mounting attachments 9¼″ lg x 9¼″ h x ⅞″ deep; principle types of items for which mounting holes are provided, 2 rotary switches, 1 toggle switch, 1 push switch, 1 meter, 4 fuses, 1 pilot light, 3 variable resistors, 1 cable compartment; marked CONTACT POTENTIAL ADJUST, OHMS ADJUST, ZERO ADJUST, —D.C.V., +D.C.V., A.C., R.F., OHMS, MA-D.C., 100uA-D.C., PRESS FOR PEAK TO PEAK, range values, ON OFF, 1 AMP, 1 AMP; four .182″ dia mtg holes on 8″ x 8½″ mtg centers; gasket 0-101 fits on mtg edges	Front panel of instrument		1-114621	A-103	1
A-104	Low failure item–if required requisition from ESO referencing NavShips 900, 180A	GUARD BAR: steel; cadmium plated finish; round cross section; over-all dim. $7\frac{9}{16}$″ lg x 1″ w x $\frac{5}{16}$″ thick; mounts w/2 screws, 10-32 thread, on 7.25″ mtg centers	Physical protection for meter face		1-115413	A-104	1
A-105	Low failure item–if required requisition from ESO referencing NavShips 900, 180A	CASE, CABLE ASSEMBLY: steel; over-all dim. $8\frac{7}{64}$″ lg x 2″ h x 5¼″ deep; 2 finger holes through bottom; contains four compartments for cable storage	Storage compartments for probes and cables		1-115260	A-105	1
A-106	Low failure item–if required requisition from ESO referencing NavShips 900, 180A	CLAMP, ELECTRICAL: steel; cadmium plated finish; over-all dim. ⅞″ lg x $1\frac{3}{16}$″ w x $1\frac{1}{32}$″ h approx, 2 mtg holes spaced .437″ c to c, tapped for 6-32 screws; designed to hold probe w/1″ od	Mounted in A-105 to position probe handle of W-104		1-115428	A-106	1
A-107	Low failure item–if required requisition from ESO referencing NavShips 900, 180A	BRACKET, INSULATOR: aluminum; over-all dim. 1″ lg x $\frac{7}{16}$″ w x $\frac{35}{32}$″ h approx; 2 mtg holes tapped for 6-32 screws spaced ½″ c to c; designed to hold and position J-101	Mounted in A-105 to position J-101 for contact w/ probe tip of W-104		1-115429	A-107	1

A-108	N17-S-250670-901	SHELL, TEST PROD: black bakelite; natural finish; cylindrical cap shape; over-all dim. $1\frac{5}{16}$" lg x 1" dia	Holds contact of probe on W-104, mounts on A-109		3-310862	A-108	1
A-109	N17-S-250670-902	SHELL, TEST PROD: aluminum; black anodized finish; cylindrical shape; over-all dim. $2\frac{3}{4}$" lg x 1" od	Houses V-101, XV-101, C-103, C-104, TB-105		3-310863	A-109	1
A-110	N16-B-801935-0505	BUSHING, ELECTRICAL CONDUCTOR: black bakelite; natural finish; over-all dim. $\frac{3}{4}$" lg x 1" dia; $\frac{1}{2}$" id	Cable feed-through, diode probe to instrument; u/w A-109		3-310870	A-110	1
A-111	N17-S-250651-0105	SHELL, TEST PROD: red polystyrene, natural finish; cylindrical shape; over-all dim. 4" lg x $\frac{5}{8}$" od	Houses R-101, p/o E-109		3-310913	A-111	1
BT-101	N17-B-7210	BATTERY, DRY: 1.5 v; over-all dim. $1\frac{5}{16}$" dia x $2\frac{3}{8}$" lg; type BA-30 per JAN-B-18	Power for ohmmeter	CBR #2	1-111798	BT-101	1
C-101	N16-C-19442-3256	CAPACITOR, FIXED, ELECTROLYTIC: 4 mf capacity; 350 v DC working voltage; case dim. $1\frac{13}{16}$" lg x $\frac{11}{16}$" dia	Power supply filter	CSF DEE	1-114774	C-101	1
C-102	For replacement use SNSN N16-C-31090-4164	CAPACITOR, FIXED, MICA DIELECTRIC: 1000 mmf capacity p/m 20%; 500 v DC working voltage; case dim. $\frac{53}{64}$" lg x $\frac{53}{64}$" w x $\frac{31}{32}$" h; type CM35A102M per JAN-C-5; for replacement use CM30B102K	DC voltage input filter		1-115246	C-102	1
C-103	N16-C-19074-6941	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 8000 mmf min; 350 v DC wkg voltage; case dim. approx $\frac{5}{16}$" dia x $\frac{1}{8}$" thick; axial leads	Series input for AC and RF in diode probe W-104	CSL Disc type, axial leads	1-115247	C103	1
C-104	N16-C-18983-1010	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 5000 mmf min; 350 v DC wkg voltage; case dim. approx $\frac{3}{8}$" dia x $\frac{1}{8}$" thick; disc type	Series input for AC and RF in diode probe W-104	CSL, GMV ceramic disc type	1-115248	C-104	1
C-105	N16-C-19111-1012	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 10,000 mmf min; 350 v DC wkg voltage; case dim. approx $\frac{5}{8}$" dia x $\frac{1}{8}$" thick; disc type	Series input for AC and RF	CSL, GMV ceramic disc type	1-114773	C-105	1
C-106	For replacement use SNSN N16-C-33622-5588	CAPACITOR, FIXED, MICA DIELECTRIC: 10,000 mmf capacity p/m 20%; 300 v DC wkg voltage; case dim. $\frac{53}{64}$" lg x $\frac{53}{64}$" w x $\frac{11}{32}$" high; type CM35A103M per JAN-C-5; for replacement use CM40B103K	Line input filter		1-115249	C-106, C-107, C-108	3
C-107		CAPACITOR, FIXED, MICA DIELECTRIC: (Same as C-106)	Line input filter				
C-108		CAPACITOR, FIXED, MICA DIELECTRIC: (Same as C-106)	Grid circuit filter for control half of V-103				
E-101	Low failure item–if required requisition from ESO referencing NavShips 900, 180A	INSULATOR, PLATE: bakelite, brown; no voltage rating; dim., MBCA Ref Dwg Group 9, K $\frac{3}{4}$", L $1\frac{1}{2}$", O 1.062", T $\frac{3}{32}$", W $\frac{1}{2}$"; no rated strength	Insulates negative battery polarity from ground		3-310864	E-101	1
E-102	N16-K-702781-106	KNOB: set screw type; over-all dim. $1\frac{3}{8}$" od, $\frac{11}{16}$" thk; natural finish; black	Knob on switch S-101	DAV #4101B, cut III, style 3	1-112719	E-102, E-103	2
E-103		KNOB: (Same as E-102)	Knob on switch S-102				

SYMBOL DESIGNATION	STANDARD NAVY STOCK NO.	NAME OF PART AND DESCRIPTION	FUNCTION	MFGR. AND MFGR'S. DESIG.	SIMPSON DWG. AND PART NO.	ALL SYMBOL DESIG. INVOLVED	NO. OF TIMES IN UNIT
E-104	N16-K-700266-616	KNOB: butyrate plastic; black; natural finish; dim. 5/8" max od; 7/16" thk over-all; fastens to shaft w/ one cup pointed set screw, 6-32	Knob on OHMS ADJUST, R-126	CAHW 6126	1-113785	E-104, E-105	2
E-105		KNOB: (Same as E-104)	Knob on ZERO ADJUST, R-156				
E-106	Modified G17-C-52581-108	CLIP, ELECTRICAL: modified alligator style #1, MBCA Ref Dwg Group 37; steel; cadmium plated finish; dim. 2 5/16" lg x 3/8" w x 5/16" h; SNSN G17-C-52581-108 plus threaded bushing tapped internally 8-32 x 1/4" deep approx	Screws over end of test probe W-101, W-102, or W-103	CBIT #60 plus modification	10-890122	E-106, E-107, E-108	3
E-107		CLIP, ELECTRICAL: (Same as E-106)	Same as E-106				
E-108		CLIP, ELECTRICAL: (Same as E-106)	Same as E-106				
E-109	Assemble from component parts	MULTIPLIER, ELECTRICAL INSTRUMENT: multiplication factor X5; designed for DC; over-all dim. approx 4" lg x 5/8" dia; increases input impedance of instrument to 250 megohms; c/o A-111, E-114, E-119, H-105, H-107, and R-101	Screws on over DC probe, W-101, for 5000 v DC range		10-890175	E-109	1
E-110	Low failure item–if required requisition from ESO referencing NavShips 900, 180A	INSULATOR, PLATE: bakelite, MIL-P-3115A, grade LTS-E1, puching stock, natural color; dim., MBCA Ref Dwg Group 9, K 1.75", L 7 3/4", O 7 3/8", P 1.937", T 1/8", W 1 3/8"	Insulated mounting for switches S-101, S-102, and S-103		3-310865	E-110	1
E-111	N16-S-34607-6039	SHIELD, ELECTRON TUBE: brass; over-all dim. 2 1/4" lg x .930" w x .838" deep; case w/compression spring locked in; TS102U03 per JAN-S-28A	Shield for tube V-102	CMG 8698-1	1-115250	E-111	1
E-112	N17-C-81579-1034	CONTACT, ELECTRICAL: p/o probe W-104; 1 point, brass, silver plated finish, dim. 5/16" lg x .080" od; silver plated contact surface; over-all dim. 25/32" lg x hex cross section 1/4" across flats; not electrically rated	Probe tip for test lead W-104		1-115257	E-112	1
E-113	N17-C-79203-7201	CONTACT, ELECTRICAL: 1 contact; 1 connector mating end; contact data, Section A, Ref Dwg Group 206 PART ONE A B C D E F G 1 FL 18 N/A NR NR NR 1 ML 10 N/A NR NR NR PART TWO H J K L N/A N/A CS WGD N/A N/A CS WGD over-all dim. 1 7/64" lg, 7/32" dia; w/o shell; not polarized; center post locking type; w/o cable clamp or conduit nut, tapped 4-40 thread by 1/8" deep; 1 mtg stud .041 to .046" dia by 1/16" lg	Receptacle for screw-on ground lead W-106, p/o W-104		1-115258	E-113	1

E-114	N17-C-803186-101	CLIP, ELECTRICAL: crocodile style #1, MBCA Ref Dwg Group 37; steel; cadmium plated finish; dim. 2⅛" lg x ⅜" w x ½" high	High voltage contactor, p/o E-109	CBIT #85	1-111875	E-114, E-115	2
E-115		CLIP, ELECTRICAL: (Same as E-114)	Ground clip for W-106				
E-116	N17-J-39851-1101	JACK, TIP: 1 contact; 1 connector mating end; contact data, Section A, Ref Dwg Group 206 PART ONE A B C D E F G 1 FL 18 N/A NR NR NR 1 ML 10 N/A NR NR NR PART TWO H J K L N/A N/A CS WGD N/A N/A CS WGD straight shape; over-all dim. 7/16" lg, 3/16" dia; center post locking type; 0.140" dia max cable accommodated, w/o cable clamp or conduit nut, threaded 4-40 by ⅛" lg, w/o cord protector, cable accommodation not at an angle to contact face; no fuse accommodated	Screws into E-113, p/o W-106		1-115286	E-116	1
E-117	N17-C-81446-1846	CONTACT, ELECTRICAL: p/o battery holder; phosphor bronze contact surface; over-all dim. approx 55/64" lg x 1 7/64" h x ½" w; spring temper material	Negative battery contact		1-115406	E-117	1
E-118	Low failure item–if required requisition from ESO referencing NavShips 900, 180A	CONTACT, ELECTRICAL: p/o battery holder; steel contact surface; cadmium plated; over-all dim. approx 1⅞" lg x 1 7/16" h x ¾" w; contact ¼" od extruded 1/16"	Grounded positive battery contact		1-115407	E-118	1
E-119	N17-C-99999-0518	COVER, ELECTRICAL CONNECTOR: red polyvinyl acetate; over-all dim. approx 2" lg x ⅝" od	Insulator over E-114, p/o E-109	CBIT #47	1-111873	E-119	1
F-101	G17-F-16302-80	FUSE, CARTRIDGE: 1 amp, 250 v; instantaneous; ferrule type, 5/16" lg x ¼" od; glass body; one time; over-all dim. 1¼" lg x ¼" od	Transformer primary overload protection	CLF 312001	1-112507	F-101, F-102, F-103, F-104	4
F-102		FUSE, CARTRIDGE: (Same as F-101)	Same as F-101				
F-103		FUSE, CARTRIDGE: (Same as F-101)	Spare				
F-104		FUSE, CARTRIDGE: (Same as F-101)	Spare				
H-101	Low failure item–if required requisition from ESO referencing NavShips 900, 180A	BASE, CHASSIS: steel; includes battery trough	Mounting for BT-101, XV-102, XV-103, E-101, E-118, T-101, and TB-102		1-115287	H-101	1
H-102	Low failure item–if required requisition from ESO referencing NavShips 900, 180A	BASE, CHASSIS: steel	Mounting for T-101, TB-102		1-115288	H-102	1

SYMBOL DESIGNATION	STANDARD NAVY STOCK NO.	NAME OF PART AND DESCRIPTION	FUNCTION	MFGR. AND MFGR'S. DESIG.	SIMPSON DWG. AND PART NO.	ALL SYMBOL DESIG. INVOLVED	NO. OF TIMES IN UNIT
H-103	Low failure item–if required requisition from ESO referencing NavShips 900, 180A	STUD, THREADED: brass; nickel plated finish; thread data, Section J, MBCA Ref Dwg Group 29, external thread #6, 32 threads per inch, NC, class 2 fit, $\frac{5}{32}$" lg, internal thread #6, 32 threads per inch, NC, class 2 fit, $\frac{5}{16}$" lg; unthreaded portion, hex cross section $\frac{5}{16}$" across flats; 2.75" lg over-all	Support for TB-101		1-115289	H-103, H-104	2
H-104		STUD, THREADED: (Same as H-103)	Support for TB-103				
H-105	N17-W-180001-197	WASHER, KEY: phosphor bronze; nickel plated; .145" dia hole; dim. .390" lg x .234" w x .008" thick	Locks parts in housing A-111, p/o E-109		3-310745	H-105	1
H-106	N43-N-9684-342	NUT, SLEEVE: open end type; brass silver plated finish; thread data, 6-32, NC, class 2 fit, 7/64" lg; .159" dia shank; $\frac{5}{16}$" nom lg over-all; hex head $\frac{1}{4}$" across flats x $\frac{1}{8}$" deep	Fastens E-112 in A-108	CMA	1-113297	H-106	1
H-107	Low failure item–if required requisition from ESO referencing NavShips 900, 180A	CONNECTOR, PLUG (TERMINAL STUD): not multiple type receptacle; 1 contact, female, round, and 1 contact, male, round, not polarized; not grounded; straight type; over-all dim. $\frac{7}{8}$" lg x hex cross section $\frac{3}{8}$" across flats; contacts not electrically rated; not radio frequency connector; cylindrical shape, brass, nickel plated finish, non-locking type, not split shell; no insert; w/o cable opening; 1 mtg hole .093" dia x $\frac{31}{32}$" deep tapped 8-32 x $\frac{7}{32}$" deep approx and 1 mtg stud threaded 6-32 x $\frac{1}{4}$" lg	Fastens R-101 in A-111, p/o E-109		1-114635	H-107	1
I-101	G17-L-6297	LAMP, INCANDESCENT: 6-8 v, .15 amp; miniature bayonet base, T 3-$\frac{1}{4}$ bulb, white light, 1 filament, tungsten C-2R; 1$\frac{1}{8}$" h max over-all; over 25 hours rated life	Indicates power on	CG #47	1-113747	I-101	1
J-101	N17-C-73108-1185	CONNECTOR, RECEPTACLE: 1 contact, female, flat; straight type; tip jack style connector, red, phenolic; over-all dim. excluding terminal $\frac{11}{16}$" lg x $\frac{1}{2}$" od	Probe contact for W-104; u/w A-107	CPH 78-IP	1-115252	J-101	1
M-101	N17-M-29347-4838	MULTIMETER, REPLACEMENT: scale data, 0 to 1000 to infinity, scale divisions not equally spaced, ohms; 0 to 10/50/250 ranges, 50 scale divisions, v/ma/ua DC and v AC and RF; 0 to 1.0 range, scale divisions not equally spaced, v AC and RF; —12 to +10 range, scale divisions not equally spaced, decibels; scale colors green for ohms, purple-blue for 1 V.A.C. ONLY, black for all others, white background; 50 uA for full scale; 2000 ohms internal resistance; w/1 piece plastic cover	Indicating meter		15-353883 Model 1029, 50 uA, 2000 ohms w/#4897 dial	M-101	1
N-101	Low failure item–if required requisition from ESO referencing NavShips 900, 180A	PLATE, IDENTIFICATION: over-all dim. 3" lg x 2" w x .020" thick; aluminum; aluminum lettering on orange background; marked MULTIMETER ME-25B/U	Nameplate		1-115263	N-101	1

N-102	Low failure item —if required requisition from ESO referencing NavShips 900, 180A	PLATE, IDENTIFICATION: over-all dim. 8½" lg x 6¼" w x .020" thick; aluminum; aluminum lettering on black background; adhesive backed for attachment	Circuit diagram		1-115264	N-102	1
O-101	N33-P-18499-8855	PACKING, PREFORMED (PACKING STRIP): Hycar Composition, 50 Durometer; nom dim., MBCA Ref Dwg Group 75, C 9¼", D 9¼", G ¼"	Watertight seal between case and cover, mtd on A-103	CALU	1-115265	O-101	1
O-102	Low failure item —if required requisition from ESO referencing NavShips 900, 180A	FASTENER, CORD ASSEMBLY: over-all dim. ¾" lg x $\frac{5}{16}$" w x ⅜" d; brass; nickel plated finish; clamps over wire .218" od	Strain relief for wire in W-104	WAL 209-0	1-113247	O-102	1
O-103	N16-B-801935-501	BUSHING, ELECTRICAL CONDUCTOR: nylon; .438" lg x .560" od; not threaded; w/insert type locking nut	Strain relief for W-101 in A-105	HEY SR-5P	1-115266	O-103, O-104	2
O-104		BUSHING, ELECTRICAL CONDUCTOR: (Same as O-103)	Strain relief for W-102, W-103 in A-105				
O-105	N16-B-801935-502	BUSHING, ELECTRICAL CONDUCTOR: nylon; .687" lg x .725" od; not threaded; w/insert type locking nut	Strain relief for W-104 in A-105	HEY SR-6P	1-115267	O-105, O-106	2
O-106		BUSHING, ELECTRICAL CONDUCTOR: (Same as O-105)	Strain relief for W-105 in A-105				
R-101	N16-R-93054-5501	RESISTOR ASSEMBLY: resistors mounted on each other w/6-32 threaded rod; matched for resultant resistance, fixed composition type, 2 resistors, series connected, 200 megohms resultant resistance, p/m 2%, 1 w individual power dissipation	High voltage multiplier resistor, p/o E-109	RPC BBF matched pair	SK-287 1-115253	R-101	1
R-102	For reference only	RESISTOR, FIXED, FILM: 5 megohms p/m 1%; ½ w; resistance temp characteristics 350 PPM/° C approx from 0° to +100° C; body dim. $\frac{5}{16}$" lg x $\frac{5}{32}$" od; p/o W-101	p/o v DC input circuit	CIR DCC	SK-321 1-115268	R-102	1
R-103	N16-R-73397-1153	RESISTOR, FIXED, FILM: 20 megohms p/m 1%; 2 w; resistance temp characteristics 0.07%/° C approx from —55° to +105° C; body dim. 2$\frac{1}{32}$" lg x $\frac{13}{64}$" od	p/o v DC input circuit	CIR DCH	SK-321 1-115269	R-103	1
R-104	N16-R-93053-6001	RESISTOR ASSEMBLY: resistors mounted on each other w/soldered leads; matched for resultant resistance, fixed composition type, 2 resistors, series connected, 20 megohms resultant resistance, p/m 1%, ½ w individual power dissipation	p/o rectified v AC input circuit	CIR BTS series matched pair	1-113202	R-104	1
R-105	N16-R-73399-3451	RESISTOR, FIXED FILM: 30 megohms p/m 1%; 2 w; resistance temp characteristics 0.085%/° C approx from —55° to +105° C; body dim. 1$\frac{5}{16}$" lg x $\frac{5}{32}$" od	p/o rectified v AC input circuit	CIR DCH	SK-321 1-115299	R-105	1
R-106	N16-R-73377-8591	RESISTOR, FIXED, FILM: 10 megohms p/m 1%; 1 w; resistance temp characteristics 0.07%/° C approx from —55° to +105° C; body dim. $\frac{13}{16}$" lg x $\frac{5}{32}$" od	p/o v AC input circuit	CIR DCF	SK-321 1-115128	R-106, R-121	2
R-107	N16-R-73390-6463	RESISTOR, FIXED, FILM: 15 megohms p/m 1%; 2 w; resistance temp characteristics 0.085% /° C approx from —55° to +105° C; body dim. 1$\frac{5}{16}$" lg x $\frac{5}{32}$" od	p/o divider network for all voltage ranges	CIR DCH	SK-321 1-115270	R-107	1

SYMBOL DESIG-NATION	STANDARD NAVY STOCK NO.	NAME OF PART AND DESCRIPTION	FUNCTION	MFGR. AND MFGR'S. DESIG.	SIMPSON DWG. AND PART NO.	ALL SYMBOL DESIG. INVOLVED	NO. OF TIMES IN UNIT
R-108	N16-R-73370-2560	RESISTOR, FIXED, FILM: 7.5 megohms p/m 1%; 1 w; resistance temp characteristics 0.07% /° C approx from —55° to +105° C; body dim. $\frac{1}{8}$" lg x $\frac{9}{32}$" od	p/o divider network for all voltage ranges	CIR DCF	SK-321 1-115271	R-108	1
R-109	N16-R-73321-1106	RESISTOR, FIXED, FILM: 1.5 megohms p/m 1%; ½ w; resistance temp characteristics 0.055% /° C from —55° to +105° C; body dim. $\frac{9}{16}$" lg x $\frac{5}{32}$" od	p/o voltage network for all voltage ranges	CIR DCC	SK-321 1-115272	R-109	1
R-110	N16-R-73271-1311	RESISTOR, FIXED, FILM: 500,000 ohms p/m 1%; ½ w; resistance temp characteristics 375 PPM/° C approx from 0° to +100° C; body dim. $\frac{9}{16}$" lg x $\frac{5}{32}$" od	p/o divider network for all voltage ranges	CIR DCC	SK-321 1-114739	R-110	1
R-111	N16-R-73231-2041	RESISTOR, FIXED, FILM: 250,000 ohms p/m 1%; ½ w; resistance temp characteristics 375 PPM/° C approx from 0° to +100° C; body dim. $\frac{9}{16}$" lg x $\frac{5}{32}$" od	p/o voltage divider network for all ranges	CIR DCC	SK-321 1-115130	R-111	1
R-112	N16-R-73209-1087	RESISTOR, FIXED, FILM: 150,000 ohms p/m 1%; ½ w; resistance temp characteristics 350 PPM/° C approx from 0° to +100° C; body dim. $\frac{9}{16}$" lg x $\frac{5}{32}$" od	p/o divider network for all voltage ranges	CIR DCC	SK-321 1-115273	R-112	1
R-113	For replacement use SNSN N16-R-73149-6868	RESISTOR, FIXED, FILM: 50,000 ohms p/m 1%; ½ w; resistance temp characteristics 350 PPM/° C approx from 0° to +100° C; body dim. $\frac{9}{16}$" lg x $\frac{5}{32}$" od	p/o divider network for all voltage ranges	CIR DCC	SK-321 1-115274	R-113	1
R-114	N16-R-73119-9122	RESISTOR, FIXED, FILM: 25,000 ohms p/m 1%; ½ w; resistance temp characteristics 550 PPM/° C approx from 0° to +100° C; body dim. $\frac{9}{16}$" lg x $\frac{5}{32}$" od	p/o voltage divider network for all ranges	CIR DCC	SK-321 1-115275	R-114, R-115	2
R-115		RESISTOR, FIXED, FILM: (Same as R-114)	p/o voltage divider network for all ranges				
R-116	N16-R-79934-4001	RESISTOR, FIXED, WIRE WOUND: inductive winding; 9.75 ohms p/m 1%; 2 w; 275° max continuous operating temp; 25° C ambient; body dim. ¾" lg x ¼" od	Ohmmeter R x 1 range resistor	TOM type S Silicohm	SK-322 1-115276	R-116	1
R-117	N16-R-72899-3021	RESISTOR, FIXED, FILM: 100 ohms p/m 1%; ½ w; resistance temp characteristics 275 PPM/° C approx from 0° to +100° C; body dim. $\frac{9}{16}$" lg x $\frac{5}{32}$" od	Ohmmeter Rx10 range resistor	CIR DCC	SK-321 1-115277	R-117	1
R-118	For replacement use SNSN N16-R-72993-5964	RESISTOR, FIXED, FILM: 1000 ohms p/m 1%; ½w; resistance temp characteristics 300 PPM/° C approx from 0° to +100° C; body dim. $\frac{9}{16}$" lg x $\frac{5}{32}$" od	Ohmmeter Rx100 range resistor	CIR DCC	SK-321 1-114742	R-118	1
R-119	For replacement use SNSN N16-R-73092-6936	RESISTOR, FIXED, FILM: 10,000 ohms p/m 1%; ½ w; resistance temp characteristics 375 PPM/° C approx from 0° to +100° C; body dim. $\frac{9}{16}$" lg x $\frac{5}{32}$" od	Rx1K Ohmmeter range resistor	CIR DCC	SK-321 1-114744	R-119	1
R-120	N16-R-73191-7761	RESISTOR, FIXED, FILM: 100,000 ohms p/m 1%; ½ w; resistance temp characteristics 350 PPM/° C approx from 0° to +100° C; body dim. $\frac{9}{16}$" lg x $\frac{5}{32}$" od	Ohmmeter Rx10K range resistor	CIR DCC	SK-321 1-115278	R-120, R-157, R-158	3

		RESISTOR, FIXED, FILM: (Same as R-106)	Ohmmeter Rx1MEG range resistor				
R-121			CONTACT POTENTIAL ADJUST	CTC Type 45 Series	1-115302	R-122	1
R-122	N16-R-88010-9644	RESISTOR, VARIABLE: composition element; 100,000 ohms p/m 20%; ¼ w nom power rating; no switch; type RV2AUSA104B per JAN-R-94					
R-123	N16-R-73400-1006	RESISTOR, FIXED, FILM: 40 megohms p/m 1%; 2 w; resistance temp characteristics 70 PPM/° C approx from —55° to +105° C; body dim. 1⅝" lg x ⅜" od	p/o isolation resistance for contact potential adjustment	CIR DCH	SK-321 1-115279	R-123, R-160	2
R-124	N16-R-73217-6001	RESISTOR, FIXED, FILM: 195,000 ohms p/m 1%; ½ w; resistance temp characteristics 350 PPM/° C approx from 0° to +100° C; body dim. ⅜" lg x ⅛" od	Bleeder circuit for contact potential adjustment	CIR DCC	SK-321 1-115280	R-124	1
R-125	N16-R-90973-8860	RESISTOR, VARIABLE: wire wound element; 4000 ohms p/m 20%; 1.5 w nom power rating; no switch	Meter calibration for DC volts, u/w R-135	CWC GC-807	1-115303	R-125, -138,-139, -140,-141, -145,-146, -147,-148	9
R-126	N16-R-87710-9502	RESISTOR, VARIABLE: composition element; 15,000 ohms p/m 20%; ¼ w nom power rating; no switch; type RV2ATFD153B per JAN-R-94	OHMS ADJUST	CTC Type 45 Series	1-115304	R-126	1
R-127	N16-R-80130-3371	RESISTOR, FIXED, WIRE WOUND: inductive winding; 157.9 ohms p/m 1%; 2 w; 275° C max continuous operating temp; 25° C ambient; body dim. ¾" lg x ¼" od	p/o ring shunt for DC milliamps	TOM type S Silicohm	SK-322 1-115281	R-127	1
R-128	N16-R-80080-8619	RESISTOR, FIXED, WIRE WOUND: inductive winding; 78.95 ohms p/m 1%; 2 w; 275° C max continuous operating temp; 25° C ambient; body dim. ¾" lg x ¼" od	p/o ring shunt for DC milliamps	TOM type S Silicohm	SK-322 1-115282	R-128	1
R-129	N16-R-99999-0903	RESISTOR, FIXED, WIRE WOUND: inductive winding; 15.8 ohms p/m 1%; 2 w; 275° C max continuous operating temp; 25° C ambient; body dim. ¾" lg x ¼" od	p/o ring shunt for DC milliamps	TOM type S Silicohm	SK-322 1-115283	R-129	1
R-130	N16-R-79919-9307	RESISTOR, FIXED, WIRE WOUND: inductive winding; 7.9 ohms p/m 1%; 2 w; 275° C max continuous operating temp; 25° C ambient; body dim. ¾" lg x ¼" od	p/o ring shunt for DC milliamps	TOM type S Silicohm	SK-322 1-115284	R-130	1
R-131	N16-R-79846-3999	RESISTOR, FIXED, WIRE WOUND: inductive winding; 1.58 ohms p/m 1%; 2 w; 275° C max continuous operating temp; 25° C ambient; body dim. ¾" lg x ¼" od	p/o ring shunt for DC milliamps	TOM type S Silicohm	SK-322 1-115285	R-131	1
R-132	N16-R-79788-9725	RESISTOR, FIXED, WIRE WOUND: inductive winding; 0.53 ohm p/m 1%; 2 w; 275° C max continuous operating temp; 25° C ambient; body dim. ¾" lg x ¼" od	p/o ring shunt for DC milliamps	TOM type S Silicohm	SK-322 1-115290	R-132	1
R-133	N16-R-79754-7119	RESISTOR, FIXED, WIRE WOUND: inductive winding; 0.26 ohm p/m 1%; 2 w; 275° C max continuous operating temp; 25° C ambient; body dim. ¾" lg x ¼" od	p/o ring shunt for DC milliamps	TOM type S Silicohm	SK-322 1-115291	R-133, R-134	2
R-134		RESISTOR, FIXED, WIRE WOUND: (Same as R-133)	p/o ring shunt for DC milliamps				
R-135	N16-R-73023-2609	RESISTOR, FIXED, FILM: 3000 ohms p/m 1%; ½ w; resistance temp characteristics 300 PPM/° C approx from 0° to +100° C; body dim. ⅜" lg x ⅛" od	Meter calibration for DC volts, u/w R-125	CIR DCC	SK-321 1-115112	R-135, R-144, R-154, R-155	4

SYMBOL DESIG-NATION	STANDARD NAVY STOCK NO.	NAME OF PART AND DESCRIPTION	FUNCTION	MFGR. AND MFGR'S. DESIG.	SIMPSON DWG. AND PART NO.	ALL SYMBOL DESIG. INVOLVED	NO. OF TIMES IN UNIT
R-136	N16-R-73111-1151	RESISTOR, FIXED, FILM: 19,500 ohms p/m 1%; ½ w; resistance temp characteristics 350 PPM/° C approx from 0° to +100° C; body dim. $\frac{9}{16}$" lg x $\frac{5}{32}$" od	Fixed minimum resistance for ohms adjust circuit	CIR DCC	SK-321 1-115292	R-136	1
R-137	N16-R-72994-5871	RESISTOR, FIXED, FILM: 1140 ohms p/m 1%; ½ w; resistance temp characteristics 300 PPM/° C approx from 0° to +100° C; body dim. $\frac{9}{16}$" lg x $\frac{5}{32}$" od	Fixed resistance in all v AC (RMS) ranges	CIR DCC	SK-321 1-115293	R-137	1
R-138		RESISTOR, VARIABLE: (Same as R-125)	Calibration for 1 v AC, RMS and P-P				
R-139		RESISTOR, VARIABLE: (Same as R-125)	Calibration for 2.5 v AC, RMS and P-P				
R-140		RESISTOR, VARIABLE: (Same as R-125)	Calibration for 10 v AC, RMS and P-P				
R-141		RESISTOR, VARIABLE: (Same as R-125)	Calibration for 25/100/250/500/1000 v AC, RMS and P-P, u/w R-142				
R-142	N16-R-73015-4351	RESISTOR, FIXED, FILM: 2300 ohms p/m 1%; ½ w; resistance temp characteristics 300 PPM/° C approx from 0° to +100° C; body dim. $\frac{9}{16}$" lg x $\frac{5}{32}$" od	Calibration for 25/100/250/500/1000 v AC, RMS and P-P	CIR DCC	SK-321 1-115294	R-142	1
R-143	For replacement use SNSN N16-R-73010-9056	RESISTOR, FIXED, FILM: 2000 ohms p/m 1%; ½ w; resistance temp characteristics 300 PPM/° C approx from 0° to +100° C; body dim. $\frac{9}{16}$" lg x $\frac{5}{32}$" od	Meter shunt for 100 microampere range	CIR DCC	SK-321 1-115295	R-143	1
R-144		RESISTOR, FIXED, FILM: (Same as R-135)	Meter series resistor for all MA DC ranges				
R-145		RESISTOR, VARIABLE: (Same as R-125)	Calibration for 1 v AC RMS range				
R-146		RESISTOR, VARIABLE: (Same as R-125)	Calibration for 2.5 v AC RMS range				
R-147		RESISTOR, VARIABLE: (Same as R-125)	Calibration for 10 v AC RMS range				
R-148		RESISTOR, VARIABLE: (Same as R-125)	Calibration for 25/100/250/500/1000 v AC RMS ranges				
R-149	N16-R-73098-6951	RESISTOR, FIXED, FILM: 12,500 ohms p/m 1%; ½ w; resistance temp characteristics 350 PPM/° C approx from 0° to +100° C; body dim. $\frac{5}{16}$" lg x $\frac{5}{32}$" od	Fixed minimum resistance for all AC RMS ranges	CIR DCC	SK-321 1-115296	R-149	1
R-150	N16-R-80305-1099	RESISTOR, FIXED, WIRE WOUND: inductive winding; 5000 ohms p/m 1%; 5 w; 275° C max continuous operating temp; body dim. $\frac{7}{8}$" lg x $\frac{5}{16}$" od	p/o bleeder for grid volts adjust in control half of V-103	TOM type S Silicohm	SK-322 1-115297	R-150	1

R-151	N16-R-90900-8387	RESISTOR, VARIABLE: wire wound element; 3500 ohms p/m 10%; 3 w nom power rating; no switch; type RA25A1SA352AK per JAN-R-19	Zero set, ground potential adjustment	CTC type 25 series	1-115305	R-151	1
R-152	N16-R-68399-8811	RESISTOR, FIXED, WIRE WOUND: inductive winding; 1000 ohms p/m 10%; 1 w; 110° C max continuous operating temp; body dim. 1¼" lg x ¼" od; type RU4B102K per JAN-R-184	Stabilizing effect on zero set voltage	CIR BW-1	1-115298	R-152	1
R-153	N16-R-80357-1199	RESISTOR, FIXED, WIRE WOUND: inductive winding; 12,000 ohms p/m 1%; 5 w; 275° C max continuous operating temp; body dim. ⅞" lg x $\frac{5}{16}$" od	p/o bleeder for grid volts adjust in control half of V-103	TOM type S Silicohm	SK-322 1-115300	R-153	1
R-154		RESISTOR, FIXED, FILM: (Same as R-135)	Range limiter for ZERO ADJUST, R-156				
R-155		RESISTOR, FIXED, FILM: (Same as R-135)	Range limiter for ZERO ADJUST, R-156				
R-156	N16-R-87190-9523	RESISTOR, VARIABLE: composition element; 1 section; 500 ohms p/m 20%; ¼ w nom power rating; not tapped; no switch; type RV2ATFD501B per JAN-R-94	ZERO ADJUST control	CTC Type 45 Series	1-115306	R-156	1
R-157		RESISTOR, FIXED, FILM: (Same as R-120)	Cathode resistor for reference half of V-103				
R-158		RESISTOR, FIXED, FILM: (Same as R-120)	Cathode resistor for signal half of V-103				
R-159	N16-R-73308-3061	RESISTOR, FIXED, FILM: 1 megohm p/m 1%; ½ w; resistance temp characteristics 400 PPM/° C approx from 0° to +100° C; body dim. $\frac{9}{16}$" lg x $\frac{5}{32}$" od	Grid return for signal half of V-103	CIR DCC	SK-321 1-115301	R-159	1
R-160		RESISTOR, FIXED, FILM: (Same as R-123)	p/o isolation resistance for contact potential adjust				
S-101	N17-S-65468-1828	SWITCH, ROTARY: 6 sections on 3 decks; 7 positions, max number of switching positions possible; 34 non-pile-up type contacts; shorting contacts; physical dim 2⅜" lg x 1$\frac{9}{16}$" w x 1⅞" deep excluding terminals and mtg bushing; flatted shaft ¾" lg x ¼" od	Function switch	COC 49188-H3	1-114770	S-101	1
S-102	N17-S-66211-9228	SWITCH, ROTARY: 8 sections on 4 decks; 8 positions, max number of switching positions possible; 57 non-pile-up type contacts; shorting contacts; physical dim excluding terminals and mtg bushing, 3$\frac{1}{16}$" lg x 1$\frac{9}{16}$" w x 1⅞" deep; flatted shaft ¾" lg x ¼" od	Range switch	COC 49189-H4	1-114771	S-102	1
S-103	N17-S-56708-3106	SWITCH, PUSH: single pole, single throw; 1 amp AC; 125 v; momentary action, normally open; over-all dim excluding terminals and actuating rod, 1$\frac{5}{32}$" lg x ½" w x $\frac{9}{16}$" h; external actuator c/o plunger w/metal cap $\frac{5}{16}$" lg	PRESS FOR PEAK-TO-PEAK switch	CHH 3391E	1-114776	S-103	1
S-104	N17-S-72828-2605	SWITCH, TOGGLE: DPST; 4 amp, 125 v AC; over-all dim., excluding bushing and handle, 1$\frac{21}{64}$" lg x $\frac{49}{64}$" w x 1$\frac{1}{16}$" high including terminals; bat handle 1$\frac{11}{16}$" lg excluding length of bushing; type ST-52K per JAN-S-23	ON OFF switch	CAE 8823-K-5	1-114777	S-104	1

SYMBOL DESIG-NATION	STANDARD NAVY STOCK NO.	NAME OF PART AND DESCRIPTION	FUNCTION	MFGR. AND MFGR'S. DESIG.	SIMPSON DWG. AND PART NO.	ALL SYMBOL DESIG. INVOLVED	NO. OF TIMES IN UNIT
T-101	N17-T-73620-9101	TRANSFORMER, POWER, STEP DOWN AND STEP UP: hermetically sealed, fully enclosed, metal case; primary 105 to 125 v, 50 to 1000 cycles, single phase; with static shield; secondary (with 117 v on primary) 290 v center tapped, 12 ma, and 5.9 v not tapped, 1.6 amp; 1500 v insulation; varnish impregnated; dim., MBCA Ref Dwg Group 12, 2⅞″ lg x 2$\frac{3}{32}$″ w x 2″ high; Grade 1, Class A, per MIL-T-27	Power transformer	CTR 17622	1-115307	T-101	1
TB-101	Low Failure Item —if required requisition from ESO referencing NavShips 900, 180A	TERMINAL BOARD: bakelite board; incl terminals, 22 post type solder lugs; over-all dim., excluding terminals, 6⅞″ lg x 3½″ w x .093″ thick; made w/type PBE-P bakelite per MIL-P-3115B	Terminal board for calibration rheostats		10-867527	TB-101	1
TB-102	Low Failure Item —if required requisition from ESO referencing NavShips 900, 180A	TERMINAL BOARD: bakelite board; incl terminals, 23 post type solder lugs; over-all dim., excluding terminals, 6¼″ lg x 3½″ w x .093″ thick; made w/type PBE-P bakelite per MIL-P-3115B	Terminal board for power supply		10-867528	TB-102	1
TB-103	Low Failure Item —if required requisition from ESO referencing NavShips 900, 180A	TERMINAL BOARD: bakelite board; incl terminals, 46 post type solder lugs; over-all dim., excluding terminals, 6⅞″ lg x 3½″ w x .093″ thick; made with type PBE-P bakelite per MIL-P-3115B	Terminal board for shunts and multipliers		10-867529	TB-103	1
TB-104	Low Failure Item —if required requisition from ESO referencing NavShips 900, 180A	TERMINAL BOARD: bakelite board; incl terminals, 8 post type solder lugs; over-all dim., excluding terminals, 2″ lg x 1⅛″ w x .093″ thick; made w/type PBE-P bakelite per MIL-P-3115B	Terminal board on rear of switch S-101		10-867530	TB-104	1
TB-105	Low Failure Item —if required requisition from ESO referencing NavShips 900, 180A	TERMINAL BOARD: bakelite board; incl terminals, 3 post type solder lugs; over-all dim., excluding terminals, ⅞″ od x .093″ thick; made w/type PBE-P bakelite per MIL-P-3115B	Terminal board in rear of diode probe W-104		10-867531	TB-105	1
V-101	N16-T-56195	ELECTRON TUBE: JAN type No. 6AL5	Rectifies AC and RF voltages	CRC 6AL5	1-115311	V-101	1
V-102	N16-T-56840	ELECTRON TUBE: JAN type No. 6X4	Power supply rectifier	CRC 6X4	1-115312	V-102	1
V-103	N16-T-56682	ELECTRON TUBE: JAN type No. 6SN7GT	Bridge tube for meter circuit	CRC 6SN7GT	1-115313	V-103	1
W-101	N17-L-63325-5451	LEAD, TEST: 1 conductor; stranded, #24 AWG, 8/36 copper and 2/31 steel, $\frac{3}{32}$″ wall polyethylene insulation, tinned copper braid shield, black plastic jacket over-all; Lenz Electric Mfg. Co. #1256; over-all lg 48″; 1 Simpson Electric Co. test probe on one end, other end stripped and tinned w/o fitting; probe on first end contains 5 megohm resistor R-102	+DCV test lead		0-008467	W-101	1

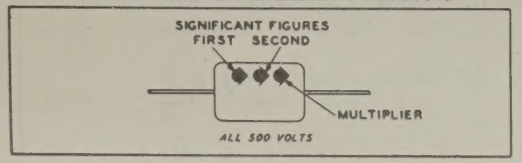
W-102	N17-L-63267-7874	LEAD, TEST: 1 conductor; stranded copper, 41/36, #20 AWG, w/cotton wrap and rubber insulation, red satin finish, wire type Alpha Wire Corp. #1635 red; approx 60" lg over-all; terminal fitting on one end, Simpson Electric Co. probe tip, other end stripped and tinned w/o fitting	AC-Ohms test lead		0-008468	W-102	1
W-103	N17-L-63236-8413	LEAD, TEST: 1 conductor; stranded copper, 41/36, #20 AWG, w/cotton wrap and rubber insulation, black satin finish, wire type Alpha Wire Corp. #1635 black; approx 60" lg over-all; terminal fitting on one end, Simpson Electric Co. probe tip, other end stripped and tinned w/o fitting	Common lead		0-008469	W-103	1
W-104	Assemble from component parts	LEAD, TEST: 2 conductors; stranded copper, 16/34, #22 AWG, wall polyethylene, 1 white, 1 red, cabled concentrically, cellulose acetate yarn braid, tinned copper shield braid, black plastic jacket over-all; Lenz Electric Mfg. Co. #1255 w/flexible jacket; approx 48" lg over-all; terminal fitting on one end, diode probe c/o A-108, A-109, A-110, C-103, C-104, E-112, E-113, J-101, O-102, TB-105, V-101, W-104A, and XV-101, other end stripped and tinned w/o fitting	Diode probe lead		0-008470	W-104	1
W-104A	N17-C-48833-2573	CABLE ASSEMBLY, SPECIAL PURPOSE, ELECTRICAL: 2 conductors; stranded #22 AWG, plastic insulation; 2 conductors covered by separate shield, plastic covering; 45" lg over-all, 0.250" dia; one end conductors separated $\frac{7}{8}$", stripped and tinned $\frac{3}{8}$", other end separated $1\frac{1}{4}$", stripped and tinned $\frac{1}{2}$"	Cable for W-104	CLE #1255	1-115345	W-104A	1
W-105	Low Failure item —if required requisition from ESO referencing NavShips 900, 180A	CABLE, POWER, ELECTRICAL: 2 conductors, #18 AWG, copper, stranded 41/34; rubber insulated, jute filler, rubber jacket over-all; 300 v working voltage; round cross section, .245" dia; 8 ft lg; w/power plug, Belden type H-1047	Power lead	COG CS-8162	1-115308	W-105	1
W-106	Assemble from component parts	LEAD, TEST; 1 conductor; stranded copper, 41/36, #20 AWG, w/cotton wrap and rubber insulation, black satin finish, wire Alpha Wire Corp. #1635 black; $33\frac{3}{4}$" lg over-all; terminal fitting on one end E-115, other end E-116	Ground lead, u/w W-104		0-008471	W-106	1
XF-101	N17-F-74267-5401	FUSEHOLDER: extractor post type; 250 v, 15 amp; accommodates 1 cartridge type fuse $1\frac{1}{4}$" lg x $\frac{1}{4}$" od; over-all dim. $2\frac{3}{32}$" lg x $\frac{13}{32}$" od	Holder for F-101	CLF 342001	1-114775	XF-101, XF-102	2
XF-102		FUSEHOLDER: (Same as XF-101)	Holder for F-102				
XF-103	N17-C-804543-476	FUSEHOLDER: clip type; designed to hold spare fuse; accommodates 1 fuse, cartridge type, $1\frac{1}{4}$" lg x $\frac{1}{4}$" od; over-all dim. $\frac{13}{32}$" lg x $\frac{7}{16}$" w x $\frac{21}{64}$" d; 1 mtg hole .128" dia	Holder for F-103	CLF 121002	1-115314	XF-103, XF-104	2
XF-104		FUSEHOLDER: (Same as XF-103)	Holder for F-104				
XI-101	N17-L-76854-4051	LIGHT, INDICATOR: w/lens $\frac{1}{2}$" dia, red, clear faceted,lens holder screws in mtg bushing; accommodates one T-3-1/4 min bayonet base lamp, MBCA Ref Dwg Group 7, w/o lamp; 55 v, 0.5 amp; over-all dim. $2\frac{35}{64}$" lg x $1\frac{1}{16}$" w x $\frac{7}{8}$" high; lamp replaceable from front of panel	Holder for pilot lamp I-101	CAYS type 20	1-114772	XI-101	1

SYMBOL DESIG-NATION	STANDARD NAVY STOCK NO.	NAME OF PART AND DESCRIPTION	FUNCTION	MFGR. AND MFGR'S. DESIG.	SIMPSON DWG. AND PART NO.	ALL SYMBOL DESIG. INVOLVED	NO. OF TIMES IN UNIT
XV-101	N16-S-62603-6895	SOCKET, ELECTRON TUBE: 7 contact, phosphor bronze, silver plated and tinned, #6 contact missing; miniature; no metal shock shield; no center shield; over-all dim. 1⅛" lg x ¾" w x ¾" deep; mtg flanges clipped for max over-all od of .834" p/m .003"	Socket for V-101, p/o W-104	CMG 53C14700 modified	3-310871	XV-101	1
XV-102	N16-S-62603-6702	SOCKET, ELECTRON TUBE: 7 contact, phosphor bronze, silver plated and tinned, no contacts missing; miniature; metal shock shield ⅛" dia x ½" high; w/center shield; over-all dim. 1⅛" lg x ⅛" w x 1⅛" high; type TSE7T101 per JAN-S-28A	Socket for V-102, u/w E-111	CMG TSE7T101	1-115309	XV-102	1
XV-103	N16-S-63515-4151	SOCKET, ELECTRON TUBE: 8 contact, phosphor bronze, silver plated and tinned, no contacts missing; octal; over-all dim. 1¾" lg x 1¼" w x ¾" deep; type TSB8T101 per JAN-S-28A	Socket for V-103	CMG TSB8T101	1-115310	XV-103	1

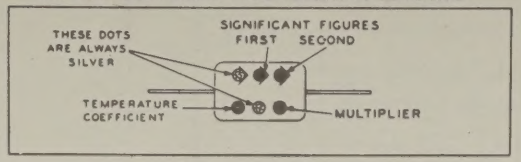
TABLE 8-2. APPLICABLE COLOR CODES.

CAPACITOR COLOR CODES

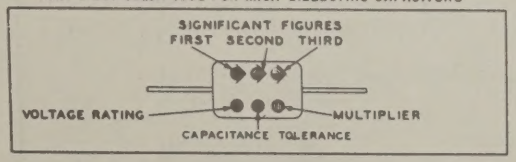
RMA 3-DOT COLOR CODE FOR MICA-DIELECTRIC CAPACITORS



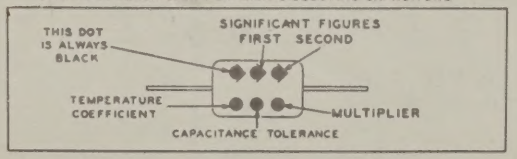
JAN 6-DOT COLOR CODE FOR PAPER-DIELECTRIC CAPACITORS



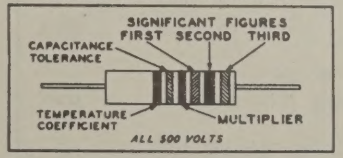
RMA 6-DOT COLOR CODE FOR MICA-DIELECTRIC CAPACITORS



JAN 6-DOT COLOR CODE FOR MICA-DIELECTRIC CAPACITORS

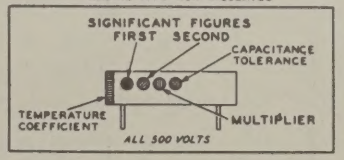


RMA COLOR CODE FOR TUBULAR CERAMIC-DIELECTRIC CAPACITORS

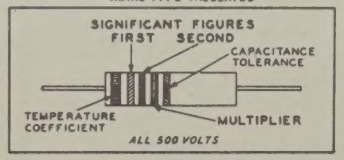


JAN COLOR CODE FOR FIXED CERAMIC-DIELECTRIC CAPACITORS

RADIAL TYPE NON-INSULATED



AXIAL TYPE INSULATED



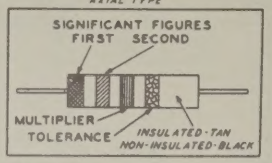
RMA: RADIO MANUFACTURERS ASSOCIATION
JAN: JOINT ARMY-NAVY

RESISTORS				CAPACITORS				
				MULTIPLIER				
TOLERANCE	MULTIPLIER	SIGNIFICANT FIGURE	COLOR	RMA MICA AND CERAMIC-DIELECTRIC	JAN MICA AND PAPER-DIELECTRIC	JAN CERAMIC DIELECTRIC	VOLTAGE RATING	TEMPERATURE COEFFICIENT
	1	0	BLACK	1	1	1		A
	10	1	BROWN	10	10	10	100	B
	100	2	RED	100	100	100	200	C
	1,000	3	ORANGE	1,000	1000	1000	300	D
	10,000	4	YELLOW	10,000			400	E
	100,000	5	GREEN	100,000			500	F
	1,000,000	6	BLUE	1,000,000			600	G
	10,000,000	7	VIOLET	10,000,000			700	
	100,000,000	8	GRAY	100,000,000		0.01	800	
	1,000,000,000	9	WHITE	1,000,000,000		0.1	900	
5	0.1		GOLD	0.1	0.1		1000	
10	0.01		SILVER	0.01	0.01		2000	
20			NO COLOR				500	

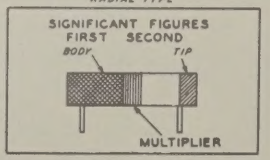
RESISTOR COLOR CODES

RMA COLOR CODE FOR FIXED COMPOSITION RESISTORS

AXIAL TYPE

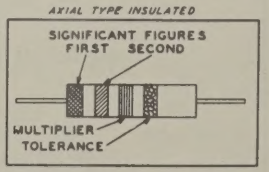


RADIAL TYPE



JAN COLOR CODE FOR FIXED COMPOSITION RESISTORS

AXIAL TYPE INSULATED



RADIAL TYPE NON-INSULATED

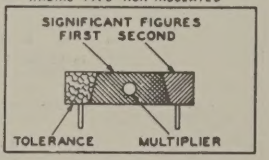


TABLE 8-3
LIST OF MANUFACTURERS

CODE	NAME AND ADDRESS
CG	General Electric Company 1 River Road, Schenectady, N. Y.
CAE	Cutler Hammer, Inc. 1333 W. St. Paul Ave., Milwaukee, Wis.
CBR	Burgess Battery Co. Freeport, Ill.
CHH	Arrow-Hart & Hegeman Electric Company 102 Hawthorne St., Hartford, Conn.
CIR	International Resistance Corporation 401 N. Broad St., Philadelphia, Pa.
CLE	Lenz Electric Co. 1751 N. Western, Chicago, Ill.
CLF	Littelfuse, Inc. Des Plaines, Ill.
CMA	P. R. Mallory Co. 1941 Thomas St., Indianapolis, Ind.
CMG	Cinch Manufacturing Co. 2339 W. Van Buren St., Chicago, Ill.
COC	Oak Manufacturing Co. 1200 N. Clybourn Ave., Chicago, Ill.
COG	Belden Manufacturing Co. P. O. Box 5070A, Chicago, Ill.
CPH	American Phenolic Corporation 1830 S. 54th Ave., Chicago, Ill.
CRC	RCA Manufacturing Co. Harrison, N. J.
CSF	Sprague Specialties Co. North Adams, Mass.
CSL	Solar Manufacturing Corporation 588 Ave. A, Bayonne, N. J.
CTC	Chicago Telephone Supply Corp. Elkhart, Indiana
CTR	Chicago Transformer Corporation 3501 Addison St., Chicago, Ill.
CWC	Wirt Company 5221 Green St., Philadelphia, Pa.
CAHW	Croname, Inc. 3701 Ravenswood Ave., Chicago, Ill.
CALU	Chicago Industrial Instrument Co. 219 W. Chicago Ave., Chicago, Ill.
CAYS	Drake Manufacturing Co. 1713 W. Hubbard St., Chicago, Ill.
CBIT	Mueller Electric Co. 1597 E. 31st St., Cleveland, Ohio
DAV	Harry Davies Molding Co. 1428 N. Wells St., Chicago, Ill.
HEY	Heyman Manufacturing Co. Kenilworth, N. J.
RPC	Resistance Products Company 714 Race St., Harrisburg, Pa.
TOM	Tomore Electric Company 131 Gould St., Rochester, N. Y.
WAL	George Walker Company Passaic, N. J.